CONSTRUCTING PARTICIPATORY ENVIRONMENTS: A BEHAVIOURAL MODEL FOR DESIGN

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Thesis submitted for PhD

I, Theodore Spyropoulos confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm this has been indicated in the thesis.

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ABSTRACT

This thesis proposes the design of cybernetic frameworks that attempt to explore architecture as ecology of interacting systems that move beyond the fixed and finite tendencies of the past towards spatial environments that are adaptive, emotive and behavioural. Environments within this framework are attempts to construct interaction scenarios that enable agency, curiosity and play, forging intimate exchanges that are participatory and evolving over time. Interaction understood as the evolving relationships between things allows a generative and time-based framework to explore space as a model of interfacing that shifts the tendencies of passive occupancy towards an active ecology of interacting agents. The work argued here moves away from known models that reinforce habitual responses within architecture, towards an understanding of adaptive systems that are active agents for communication and exploration. Architecture within the context of this thesis is explored as a medium for spatial interfacing. Design is thus considered as durational, real-time and anticipatory exploring human human, human machine, and machine machine communication. The challenge posed is how designers can construct environments that are shared, enable curiosity, evolve and allow for complex interactions to arise through human and non-human agency. Attention thus is placed on behavioural features that afford conversational rich exchanges between participants and system, participants with other participants and or systems with other systems. This evolving framework demands that design systems have the capacity to participate and enable new forms of communication. Beyond conventional models that are reactive in their definition of interaction, architecture here moves towards features that are life-like, machine learned, and emotively communicated. The thesis demonstrates and articulates concepts of participation and behaviour through authored prototypes and real-time experiments. Behaviour is not relegated to a generative process in the design phase; rather it is time-based and conversational constantly constructing models of and for communication.

PREFACE

Embracing design as a mode of intellectual enquiry through the construction of experiments that are real-time and observable opened a sensitivity and reconceptualization that fundamentally changed my understanding and motivation for design. Making as a form of thinking became a critical vehicle to move beyond representation towards a method of working that was operative and prototypical. Design research within this thesis expanded definitions and limits of terms of reference and allowed this thesis to evolve and contribute to a legacy of experiments in particular to second-order cybernetic works that challenged models of communication. It is through this active exploration that fields of cybernetics, adaptive systems, robotics and performance contributed to influence my work and evolve the limits that I found in formal design discourses at the time that were categorised and remain dominant today as “digital” or “computational” design within architecture. In my own practice based history working in offices such as Peter Eisenman and Zaha Hadid the challenges that I encountered where of geometric and material translation. Dynamism and generative approaches were relegated in those early days to form generation and remained in a finite and iteratively selected state.

The challenge that I believed when beginning this thesis and that remains to this day was that a framework could be explored for architecture to move beyond form towards a model of space as an interface that was adaptive, time-based and emotive. In considering a way to explore this agenda an active development of observable experiments were designed, fabricated and installed as real-time constructs. Many of the featured experiments within this thesis were performed in multiple contexts to test assumptions and discover through direct experience

how these prototypes could be understood with respect to context and public engagement. The attempt from the outset has been and remains to create a framework that enables communication and interaction. The discovery through these installations has been an attention and sensibility towards enabling, engagement and communication that has brought about shared experiences, curiosity and wonder. The process of development and discovery has not been linear. Through self-reflection the research projects and experiments have allowed for continuity, feedback and an evolving complexity in the nature of enquiry. The capacity to shift from representational or illustrative means of design towards prototyping proofs of concepts have given the space and attention to aspects of the design research projects to contribute actively to the wider field. In the spirit of how artist Robert Morris regarded his own work as a “continuous project altered daily” [1] and attempted to situate his work within the expanded field of sculpture it is my hope that the work will be accessible to an evolving field of behaviour based design within architecture.

1 Morris, Robert. 1993. Continuous Project Altered Daily: The Writings of Robert Morris. Cambridge, Mass: MIT Press.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to Professor Stephen Gage and Professor Alan Penn, my research supervisors, for their patient guidance, enthusiastic encouragement and useful critiques of this research work. I am extremely grateful to the late Supervisor Dr. Ranulph Glanville for his support and passionate challenges to explore the cybernetics of design. He introduced me to a world of cybernetics and it has resonated since in my work and thinking.

I would like to thank my colleagues and students at the AADRL who have discussed and debated with me many of my thoughts on architecture and design. I would like to thank Brett Steele, Patrik Schumacher, Mohsen Mostafavi, Homa Farjadi, Krzysztof Wodicziko, Stelarc, Frédéric Migayrou, Marie Ange Brayer and David Greene for their encouragement and support.

I would like to express my deepest appreciation to my brother Stephen Spyropoulos. His encouragement and love has been my inspiration to continue to explore design together.

Finally I am indebted to the love, support and encouragement of my mother Ekaty Spyropoulos for who I dedicate my thesis to her and my late father Efstathios Spyropoulos. My mom’s strength and encouragement have guided me throughout my life and without her support this would have never been possible.

FIGURES

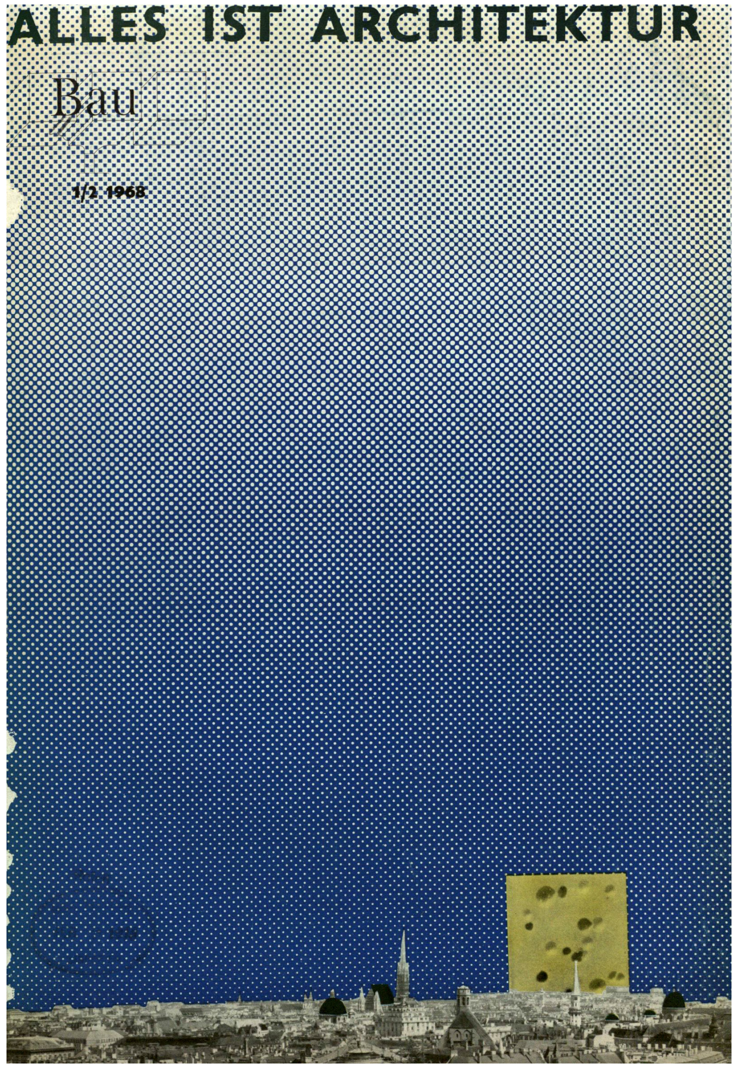


Figure 1: Hans Hollein, All is Architecture (1968)

Hans Hollien's thirty page contribution to Bau: Zeitschrift für Architektur und Städtebau (Bau: Magazine for Architecture and Urban Planning) titled "All is architecture" was a calling to architects to consider architecture in a expanded cultural framework where the solid and fix forms of building where thrown into crisis.

CONSTRUCTING FRAMEWORKS FOR HUMAN MACHINE ECOLOGIES

"It's going to be harder to distinguish: what is alive and what is a machine... And that boundary may start to become meaningless."

Rodney Brooks, *Fast,Cheap, and Out of Control [January 7, 1997] RT: 83 minutes*

In 1968, Austrian radical architect Hans Hollein proclaimed, "*Alles ist Architektur (Everything is Architecture)*." Published originally as a manifesto that appeared in the journal *Bau,* it was a provocation that reflected a heightened awareness of the limitations of traditional definitions of architecture in favour of an understanding of design as an experimental vehicle for the construction of new forms of communication. Beyond building Hollein stated; "A true architecture of our time will have to redefine itself and expand its means. Many areas outside of traditional building will enter the realm of architecture, as architecture and "architects" will have to enter new fields. All are architects. Everything is architecture.[1]" Architecture in an expanded field of experimentation resonates with great magnitude today as we live in an age where science fiction has become science fact. Our contemporary age is as radical as ever with change, latency and uncertainty being the new norm. The once comfortable and

1 Hollein, H. (1968) 'Alles ist Architektur', Bau : Magazine for Architecture and Town Planning. Available at: https://www.ica.org.uk/sites/default/files/Press%20Release%20Everything%20is%20Architecture.pdf.

understood historical models of the past have proven limited in their capacity to engage and address the complexities of the contemporary condition. As we live in ever-evolving information-rich environments, the question is not why by how architecture can actively participate.

Hollien's proclamation like others during this period of the late sixties looked outside of traditional architectural discourse and practice of the time in an attempt to radically rethink what architecture could be. Experimentation extended from pure speculative design to novel research in ephemeral structures, material computation and systems thinking. Beyond technological optimism a cultural project emerged that questioned how we live and the environments that we lived within. This open interrogation and plurality of approaches created a culture of design that was socially aware and forward thinking. Within the context of this research attention has been given to a strand of experiments and research initiatives that focused on the role of cybernetics, communication, art and technology during the mid sixties till 1970. Experiments for Art and Technology / E.A.T. (1966), M.I.T.'s Architecture Machine Group (1967) and Centre for Advanced Visual Studies (1967) along with land mark exhibitions such as Jasia Reichardt's Cybernetic Serendipity (1968) and Jack Burnham's Software: Information Technology: Its New Meaning for Art (1970) all pointed to a diverse terrain of approaches within the artistic, scientific and technological fields that were converging in exciting and yet to be understood ways. The attempts within these experiments were to speculate and correlate relationships, construct understandings through experimentation. Through thought experiments and scenario speculation this short but seminal period brought about a motivated design synergy, which will be argued, can offer new perspectives for some of the challenges that we face in contemporary design.

In September 1969 a landmark issue of Architectural Design, guest edited by Roy Landau, brought issues of interaction and digital computation into the mainstream architectural media. Alongside articles by Nicholas Negroponte, Cedric Price and Warren Brodey, the issue featured an essay by the cybernetician Gordon Pask, who introduced the idea that 'architects are first and foremost system designers who have been forced to take an increasing interest in the organisational systems properties of development, communication and control'. Architecture, Pask argued, had no theory to cope with the pressing contemporary complexities of the time, and it was only through a cybernetic understanding of systemic processes that the discipline could evolve.

Central to Pask's argument was an understanding of the world through the pursuit of 'communication and control' and the elucidation of what he termed 'aesthetically potent environments': external spaces designed to foster pleasurable interactions. These interactions were to be framed through a commitment to novelty. 'Man', he wrote, 'is prone to seek novelty in his environment and, having found a novel situation, to learn how to control it'. The pioneering cybernetic issue of AD was in many ways anticipated (with an obvious sense of dread) five years earlier in 1964, when Herbert Read published his *A Concise History of Modern Sculpture*. Writing about what he saw as the 'tortuous dematerialisation of postwar sculpture', with more recent works resembling merely 'scribbles in the air', Read argued that sculpture's only hope for salvation lay in the pursuit of stability, 'an art of solid form'. In his own book, *Beyond Modern Sculpture*, four years later, the US art historian Jack Burnham responded to Read's broadside by suggesting that the survival of sculpture would depend on its ability to offer a 'transition from object to system'. In a spirit very similar to Pask's call to architectural arms, Burnham argued for the importance of systemic innovation, pursued specifically through kinetic installations, light sculptures

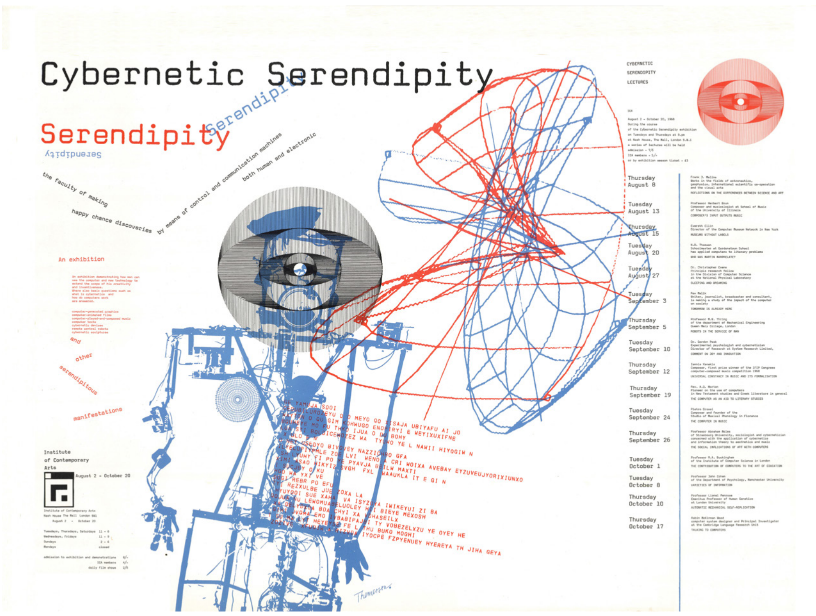


Figure 2: Jasia Reichardt's Cybernetic Serendipity (1968)

ICA in London seminal exhibition curated by Jasia Reichardt set out to take stock through a cybernetic framework emerging approaches towards creativity and technology across fields that included computer science, computer art, music and mathematics.

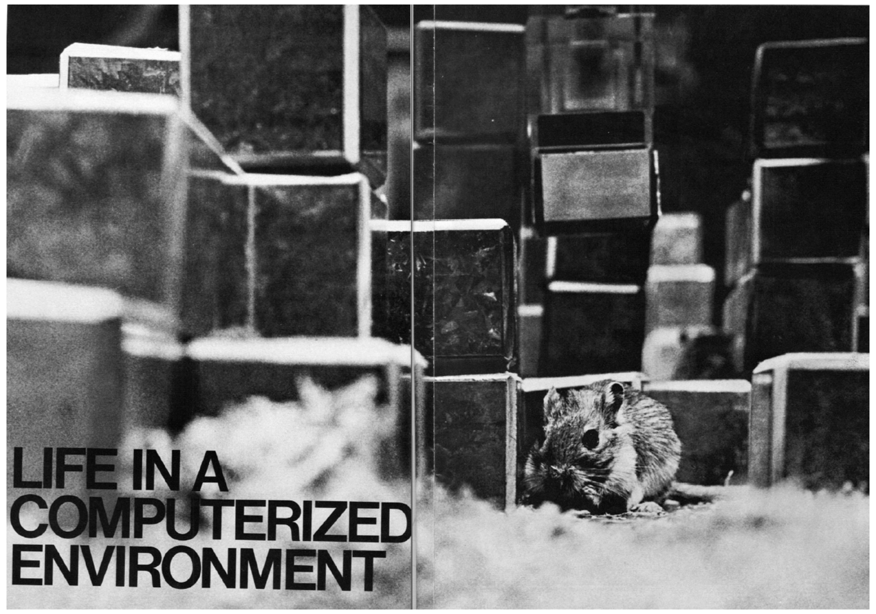


Figure 3: Nicholas Negroponte (AMG) Seek at the Jewish Museum in New York (1970)

The Architecture Machine Group led by Nicholas Negroponte produced Seek, a computer-controlled environment inhabited by gerbils as part of Jack Burnham's 1970 'Software' show in New York.

and cybernetic art. As a main feature of this research operative installations and prototypes serve to expand this systemic approach towards a model that is participatory and behavioural in practice.

Cybernetics as a subject of enquiry has within this research been of great importance and informs the approach to design research in both method and practice. English psychiatrist William Ross Ashby in his landmark book titled *An Introduction to Cybernetics* published in 1956 articulates its early conceptual framework when he states, "Cybernetics… is a "theory of machines" but treats, not things but ways of behaving. It does not ask "what is this thing?" but "what does it do?"… It takes as its subject matter the domain of "all possible machines," and is only secondarily interested if informed that some of them have not yet been made, either by Man or by Nature. What cybernetics offers is the framework on which all individual machines may be ordered, related and understood."[2] Behaviour as subject in early cybernetic discourse made little to no distinction between objects, organisms or machines, and only considered agency as a product of an entities capacity to produce change in an environment. This served as a fundamental driver for the behavioural classification proposed in the seminal paper titled "*Behavior, Purpose, and Teleology*,"[3] published in 1943 by authors Arthur Rosenblueth, Norbet Wiener, and Julian Bigelow which influenced some of the core conversations at the cybernetics conferences held between 1946 and 1953 at the Josiah Macy, Jr. Foundation.[4] Furthering Ashby's questioning of what

2 Johnston, John, 'The Allure of Machinic Life: Cybernetics, Artificial Life, and the New AI', The MIT Press, 2008. Pg.11

3 Rosenblueth, Arturo; Wiener, Norbert; Bigelow, Julian (Jan 1943). "Behavior, Purpose and Teleology". Philosophy of Science. 10 (1): 21

4 The Macy Conferences brought together a diverse group of cross-disciplinary scholars that included mathematician and computing pioneer John von Neumann, founder of cybernetics Norbert Wiener, social scientist Gregory Bateson, cultural anthropologist Margaret Mead, biophysicist Heinz von Foerster, father of information theory Claude Shannon, amongst others. The meetings were foundational in the development of cybernetics and systems theory.

things do, Andrew Pickering in his book *The Mangle of Practice: Time, Agency and Science* makes an important distinction with what he sees in second-order cybernetics as shift from "the representational idiom" to what he states as "the performative idiom." The representational idiom maps the world and describes it as it is, while the performative idiom is concerned with agency and influencing this world through action. Pickering sees this as "the emergent interplay of human and material agency"[5]. Within the context of this thesis I have described it as interplay between human and non-human agency.

The convergence of cybernetics, anthropology, conceptual art, and complexity sciences brought about thought experiments that reconceptualised our "understanding of understanding" as Heinz Von Foerster would say. A conceptual framework that would acknowledge the observer as not something outside of the system but within a system challenged the orthodoxies of scientific method and the finite results that were ascribed to them. Von Foerster's articulated this distinction between "observed systems" and "observing systems" as a foundational development in what became known as second order cybernetics or the cybernetics of cybernetics. This conception of understanding within this research has been of great importance as it has offered a new perspective for how one could conceive of design systems within a shared environment. Observing systems that could engage other systems in a manner that privilege communication, learning and experience. Von Foerster's spoke to this in a presentation he made at the University of Illinois, Urbana titled Cybernetics of Cybernetics in 1979 where he reminded the audience of biologist and theoretician Humberto Maturana's famed proposition, "Anything said is said by an observer" which he followed up with a request to expand this by adding

5 Pickering, Andrew (1995). "The Mangle of Practice Time, Agency, and Science." Chicago, Illinois: University of Chicago Press.

"Anything said is said to an observer."[6] The thesis expands this observer function towards implications that Second Order cybernetician Gordon Pask articulates and pushes further in his conversation theory. His concept of conversation as a model of interaction enables a framework that is both open and informal but contingent on communication and engagement. Conversations can start from anywhere, but are between participants, they can last as long as that engagement is necessitated and agreed between participants. The rules of interaction are formed through the engagement and the content or subject of discussion can migrate and evolve as parties see appropriate. A conversation as understood by Pask is circular and can be conducted with a human, machine or with ones self. This will be expanded in particular within the first two chapters of this thesis.

Of and In the World: A Second Order Approach

Second order cybernetics within the framework of this thesis sets the core theoretical component. Evolving from first order cybernetic command and control practices, second order cybernetics made an obvious yet profound inclusion of the observer within the observing system. Known as the "cybernetics of cybernetics" the observer is actively engaging and relationally evolving understandings with the observed. This inclusion expanded the complex set of circular relationships that every observer engages with when they attempt to understand the processes and knowledge extracted from their observations. Fundamentally this brought into question deterministic and finite understandings of how we conceptualise, perceive, represent and communicate. Second order cybernetician Ranulph Glanville explains that, "the observer is no longer neutral and detached... The aim of attaining traditional objectivity is either abandoned / passed over, or what objectivity is and how we might obtain (and value) it is reconsidered. In this sense, every obser-

6 Foerster, H von (1979) "Cybernetics of Cybernetics", Biological Computer Laboratory University of Illinois, Champaign-Urbana

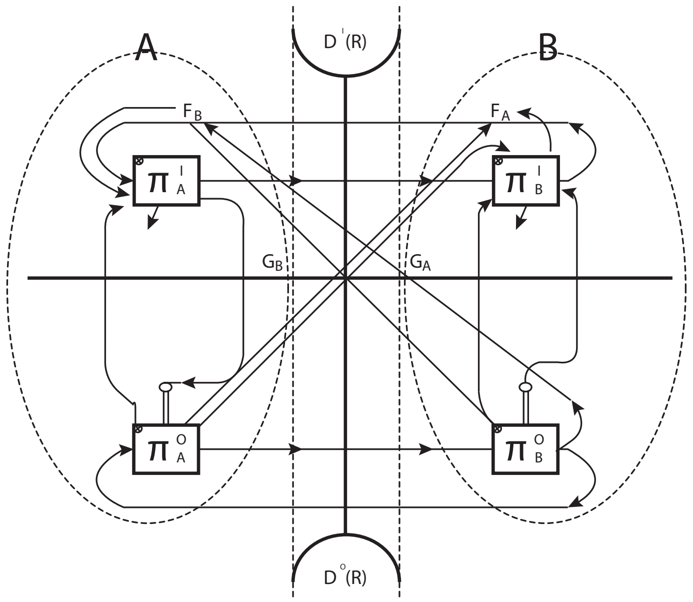


Figure 4: Gordon Pask's Conversation Theory

One of many diagrams Pask outlined to communicate the circular relations between two individuals in conversation.

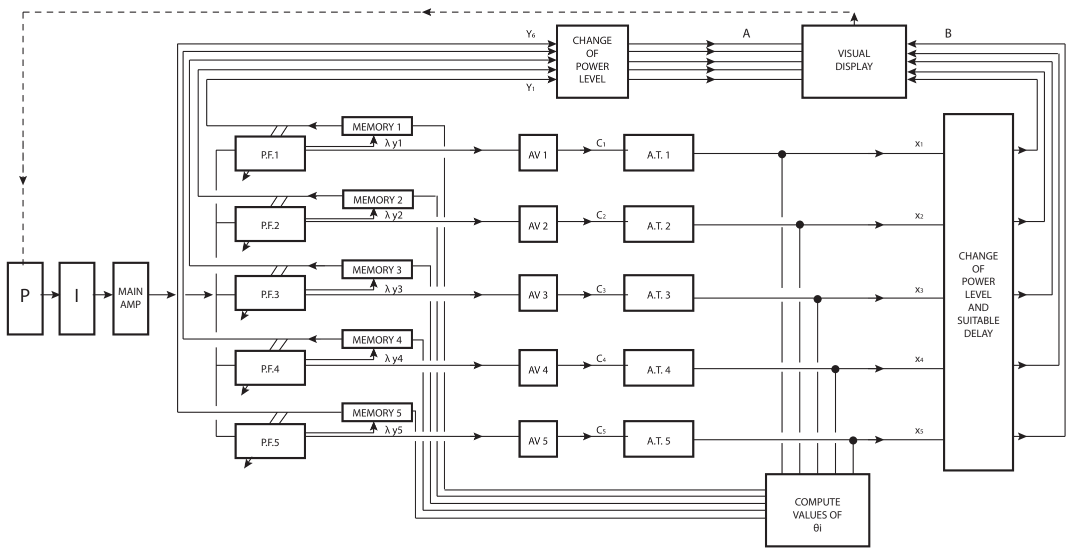


Figure 5: Gordon Pask's Musicolour Logic Diagram

The wire diagram illustrates the relational frameworks of one of Pask's early cybernetic theatrical machines. Musicolour sought to demonstrate through sound and light theatrical performance that attempted to communicate and choreograph its illumination in dialogue with the musical performers to achieve synesthetic human machine assemblage.

CONSTRUCTING FRAMEWORKS

vation is autobiographical."[7] What Glanville and other second-order cyberneticists foreground is the presence of an observed agency that through interaction, engagement or experience connect and directly situate their observations within a behavioural framework that is truly theirs. This is stated throughout the literature of second-order cybernetics and within the philosophical discourses of the radical constructivists. Radical constructivist Bernhard Poerksen states "the observer is the point of fixation for all divergent interests; the observer, by general consent, plays the central role in any cognitive process. Despite all the differences, such a common research interest is in itself of great consequence, of course, because it entails the need to re-assess the investigative efforts of one's own in relation to those of others."[8] Within second-order cybernetics and constructivists' discourse, questions of difference, distinction and change all influence the attention and possibilities that could be ascertained through observation. This sets up a conceptually beautiful problem, which in acknowledging that each observers' observations are their own and are inherently inaccessible to others in pure form.

Ranulph Glanville implies a behavioural understanding of this paradox when stating, "while we all observe and know differently, we behave as if we were observing the same thing. What structure might support this? One supporting the essential difference while retaining the possibility of communication: when the basic assumption is that we are all different, we all see and understand differently."[9] Communication and the interface of our interaction with each other, our environment or with non-human agents therefore cannot be assumed. Sociologist Andrew Pickering argues that "Cybernetics stages for us a vision not of a world

7 Glanville, R. (2003) 'Second-Order Cybernetics', EoLSS Publishers. Available at: http://www.univie.ac.at/constructivism/archive/fulltexts/2326.html (Accessed: 7 June 2017).

8 Poerksen, B. (2004) Certainty of Uncertainty: Dialogues Introducing Constructivism. Exeter: Imprint Academic. Pg. x

9 Glanville, R. (2003) 'Second-Order Cybernetics', EoLSS Publishers. Available at: http://www.univie.ac.at/constructivism/archive/fulltexts/2326.html (Accessed: 7 June 2017).

characterized by graspable causes, but rather of one in which reality is always "in the making," to borrow a phrase from William James. We could say, then that the ontology of cybernetics was non-modern in two ways: in its refusal of a dualist split between people and things, and in an evolutionary, rather than casual and calculable grasp of temporal process."[10] Pickering expresses these primary cybernetic qualities that have played a vital role in my revisiting this approach to observation and understanding as the critical framework to enable curiosity, conversation and adaptation within practice. The situated complexity of observers, the environment of this observation, and the potential to draw out communication and shared experience motivates the underlying premise argued as a behavioural framework for design within this thesis. The role of this framework to engage in real-time with the complexities of communication within a collective is hypothesised through a model for interaction as conversation. Enter design.

The strength of second order cybernetic discourse could be argued resides in its plurality of method for breaking disciplinary orthodoxies. Gregory Bateson (anthropologist, social scientist and biologist), W. Ross Ashby (psychiatrist), Walter Grey Walter (neurophysiologist), Ranulph Glanville (architect and educator) shared a complex second order framework that enabled them to consider how observers (human and non-human agents) constructed through participation an understanding of their world. Through this plurality and individuated observer understandings, the need to examine frameworks that explore new forms of communication that are collective and shared motivates much of the design research that has been developed as authored experiments. This behavioural framework developed within this thesis is argued as participatory and conversational allowing for potential exchanges that offer the possibility for what Bateson would

10 Pickering, A. (2010) The Cybernetic Brain: Sketches Of Another Future. Chicago, Ill: University of Chicago Press, pp. 309–371.

say "is a difference which makes a difference."[11] Bateson saw the capacity of observers to actively engage with differences especially within their environment through what he spoke of as "ecology of mind." This conceptual apparatus of Bateson was not predicated on bounded singularities but rather defied holistic understanding; he states, "The mental world –the mind—the world of information processing—is not limited by skin."[12] Beyond skin for Bateson (or any form of materialism) is the desire to see thoughts as having agency they further transform from the thing itself into an ecology of ideas that may find form he speculated in art. Bateson went further to express the fundamental human aspect of observation and understanding. He said, "it is the attempt to separate intellect from emotion that is monstrous, and I suggest that it is equally monstrous—and dangerous –to attempt to separate the external mind from the internal."[13] The emotive aspect of the observer offers a window into the human complexities within an observer's construction and the need to conceptualise a framework to allow for this to be shared. Bateson followed by suggesting that "there are bridges between one sort of thought and the other, and it seems to me that the artists and poets are specifically concerned with these bridges. It is not that art is the expression of the unconscious, but rather that it is concerned with the relation between levels of mental process."[14] In considering Bateson's cybernetic considerations it is noteworthy to see some parallels developed with experimental art practice during this period.

Like Bateson, performance artist Allan Kaprow shared an interest in the environ-

11 Bateson, G. (1977) *Steps to an Ecology of Mind*. New edition. Northvale, NJ: Jason Aronson Inc. Publishers. pg. 459

12 Ibid pg. 460

13 Ibid pg. 470

14 Bateson, G. (1977) *Steps to an Ecology of Mind*. New edition. Northvale, NJ: Jason Aronson Inc. Publishers. Pg. 470

ment. Kaprow pioneered a movement of performance art that he described as "Happenings" and "Environment" art. If Bateson and other cyberneticists believed in active observer principals, Kaprow would describe these principals as experience. He stated that he wanted to understand "art not separate from experience… what is an authentic experience?... environment is a process of interaction… even a crude experience, if authentically an experience, is more fit to give a clue to the intrinsic nature of aesthetic experience than is an object already set apart from any other mode experience."[15] This gives a window in why Kaprow believed that there should be no distinctions between art and life. He believed in what he described as "performing life". Kaprow like Gordon Pask believed that art had constraints. Kaprow stated that "A work of art, like an experience, has its limits; the questions are, what kind limits and do they model themselves after those in other art or in life? "[16] What is central in this intellectual enquiry is that this thought experiment is relational and by actively engaging in this the observer is influenced by and influences their environment through this enquiry. Pask would describe this environment as an "aesthetically potent environment" which would foster "pleasurable" forms of interaction. What constitutes an observer in this environment is agency and through novelty Pask believed human curiosity would exhibit the desire to control it. In contrast this would challenge some tenets of second order approaches such as cyberneticist Ross Ashby's belief that "Cybernetics deals with all forms of behavior in so far as they are regular, or determinate, or reproducible. The materiality is irrelevant, and so is the holding or not of the ordinary laws of physics." Beyond thought the thesis is concerned with constructing frameworks that are operational, have the capacity to observe, respond and act in the world. I would argue it is this performativity in constructing cybernetic machines / frameworks that enable design to expand and offer new knowledge through experiments that serve as proof of evolving concepts. The thesis within this understanding is greatly influenced by Pask's concepts of conversation theory that evolved through his making of machines that learned, his interests in the dramatic arts and architecture and his desire to explore a form of humanity in humans or machines. In discussing Pask's work in his book a *The Cybernetic Brain: Sketches Of Another Future*, Pickering defines his "interest in conversation, understood very generally as any form of reciprocally productive and open-ended exchange between two or more parties (which might be humans or machines or humans and machines) was, in fact, the defining topic of all of Pask's work."[17] This attention to environment and performance within second order cybernetics and the deeper circular relations that are understood through interaction and experience set the stage for this thesis and the active role the design experiments play in constructing participatory environments.

15 Kaprow, A. (2003) Essays on the Blurring of Art and Life. Expanded ed edition. Berkeley, Calif: University of California Press. Pg. xi Introduction

16 Ibid. pg. Xvii

Participants as Performers

Spatial environments as ecologies of interaction serve as a stimulus for participation. Participatory models offer dynamic and intuitive relationships between the environment, observers and performers within the system. It is through this participatory model for interaction that one sees that architecture can serve as a host to enable scenario-based exchanges that amplify space as an interface for communication. This communication in principal can be human or non-human. The project-based research particularly in the early experiments within this thesis pays particular attention to human agency in an attempt to explore new forms of communication that challenge conventional systemic

17 Pickering, A. (2010) The Cybernetic Brain: Sketches Of Another Future. Chicago, Ill: University of Chicago Press, pp. Pg 322-323

approaches of finite programming and control. The architecture argued for is active, anticipatory and adaptive through continuous exchanges that are real-time and behavior based. Architecture is understood to have agency; to sense, to learn, to stimulate, to understand and to get bored.

Through direct experience participants' evolve their novel relations into enquiry and constructive understanding. This dialogue between things that emerges through curiosity and play can exhibit collective tendencies that can be experienced as intelligent. Intelligence Dr. Ranulph Glanville reminds us in his paper *An Intelligent Architecture, "is experienced by us."* He continues, "from individual instances we have observed: that is, we observe, we generalize (find pattern) and we create the concept of intelligence, which we then both modify as we go, and allow to determine whether various acts and behaviors we observe are intelligent or not."[18] The move towards a spatial and conversational model of interaction pursues a definition of an intelligent architecture in the spirit that Ranulph Glanville has defined. "Intelligence depends on the interface of our interaction."[19] The challenge posed is to construct environments that are shared between participants and allow for complex interactions to arise through human agency and the observed agency of these interactions. The concept of intelligence explored within this thesis is not attributed to things as a property but something arsing between things, a product of interface and interaction.

18 Ranulph Glanville. An Intelligent Architecture Convergence: The International Journal of Research into New Media Technologies June 2001 vol.7 no.2: pg.2

19 Ibid pg. 8

THESIS STRUCTURE

The structure of this thesis is organised through three main chapters. Each chapter organised to feature a particular aspect of interaction and communication that has been examined through design experiments conducted by the author.

The first chapter focuses on ***Human Human*** interaction, which highlights live experiments that explore enabling and participation of an individual within a collective. The projects are participatory in nature and focus their design development through the construction of a system that facilitates engagement through audience contributions. Installation has served to offer a means to examine participatory scenarios within this thesis. These series of real-time live experiments have sought to articulate and demonstrate key concepts through the design, fabrication and implementation. Through out the process and within the design development of each project there has been an attempt to articulate a form of enabling that allows users to contribute to and communicate through the work. This communication and user enabled contributions include early experiments that used portraiture in works like Facebreeder and short form text messages that formed part of an evolving text that was projected within a public space in works like Memory Cloud. These installations have afforded this research an observable framework that allows participants to play the role of performers and users of the environment. Observers in these environments play an active role as they create context specificity and immediacy that allows the interactions between participants to stimulate and construct deeper relations through the installation. The public aspect of this shared experience creates a context where human interaction between participants is stimulated through the collective expressions amplified by the design system. Contextual and durational parameters are examined to test assumptions in multiple contexts allowing for a

case study approach to be articulated between setup, environment, audience and duration. Installation within this thesis is an open framework that has evolved through interaction and participation. A key example of this can be seen in the work of Memory Cloud, which was installed and performed in four public contexts over a five-year period. Originally installed in Suffolk, England in 2006, Bristol, England in 2007, London (Trafalgar Square), England in 2008 and the concluding performance in Detroit (DIA), United States in 2010. As the research has evolved over the years the process of exploring concepts of enabling have evolved with each new work. The progression of each work itself is not to be understood as linear, rather circular, installations themselves have offered a means for a reflective and nuanced rearticulating of fundamental thesis questions concerning the role of design and communication between the systems of interaction and the environment in which has been constructed through this engagement. These evolving questions regarding the nature of interaction within a time-based environment has given insight towards participants continued pursuit of novelty and control, the role of personal and projective contributions towards sustained engagement, the theatre of the behavioral responses when participants perform in self-forming contexts of other participants. Summarized by cybernetician Gordon Pask when he states, “When learning to control or to solve problems man necessarily conceptualizes and abstracts. Because of this, the human environment is interpreted at various levels in a hierarchy of abstraction. These propensities are at the root of curiosity and assimilation of knowledge. They impel man to explore, discover and explain his inanimate surroundings. Addressed to the social environment of other men, they lead him into social communication, conversation and other modes of partially co-operative interaction.” [20]

20 Pask, Gordon, ‘A Comment, a Case History and a Plan’, in J Reichardt, Rapp and Carroll (eds), Cybernetic Serendipity, 1970, reprinted in J Reichardt (ed), Cybernetic Art and Ideas (London: Studio Vista, 1971), p 76.

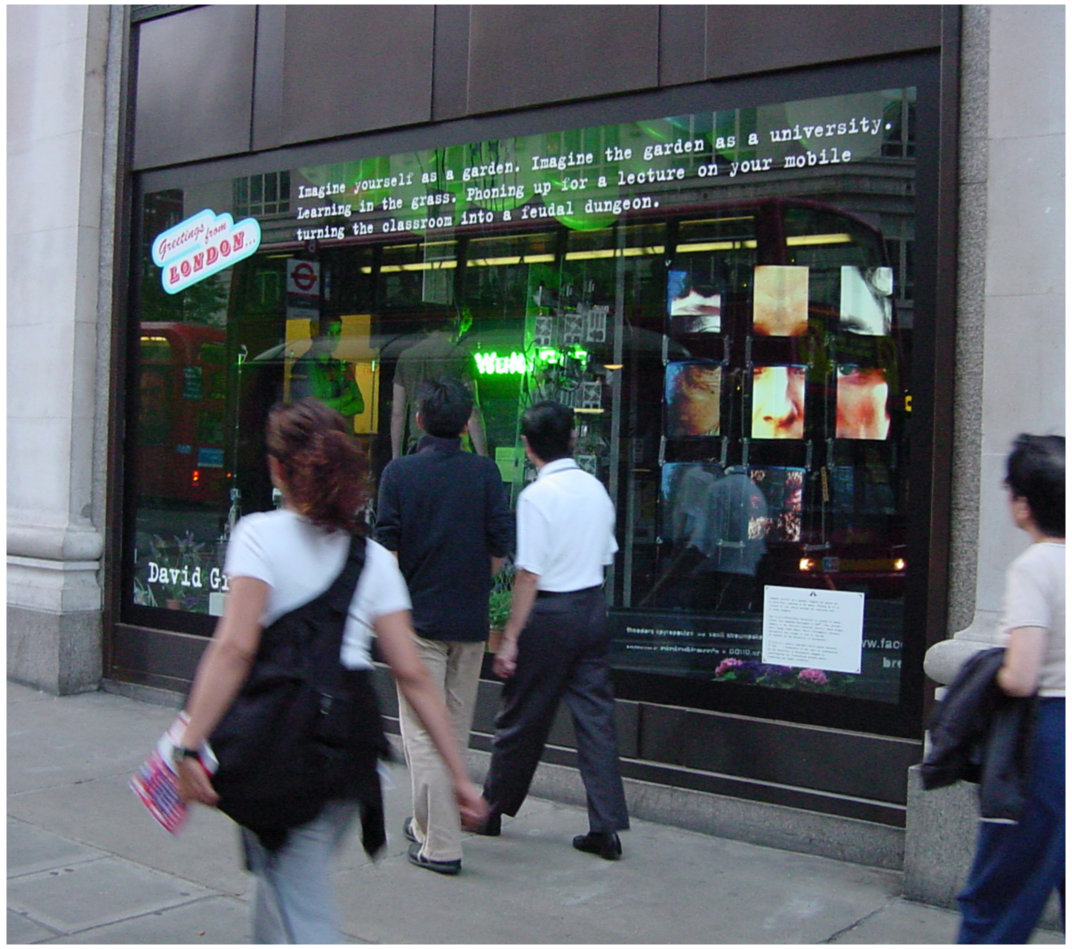


Figure 6: Facebreeder (2004)

Through the use of portraiture as a stimulus, participation and playful interactions were enabled through the simple display and auto-generative compositing of portraits. Participants exhibited varied magnitudes of anticipation and recognition with portions of images of their own identity. The wire diagrams illustrate the systems internal logic.

Human Human features the design of two authored installations *Facebreeder* and *Memory Cloud* that were designed as environments that engaged participants through their contributions to the installation. These experiments were conducted in multiple venues and public spaces, which through observation highlighted scenario, context specificity and collective experience as important influences in understanding the witnessed exchanges. The work developed in this chapter examines the role of the contribution and how through portraits or sms text messages complex interactions could be facilitated between participants within a shared environment. The design installations in this chapter create a forum for communication through the capacity to animate and amplify participants' contributions within a collective arena. The systems designed here extend personal communications and enable a collective act of communication to evolve as shared experience. Facebreeder and Memory Cloud will be situated in relation to contemporary artist Rafael Lozano Hemmer work. Two projects of Hemmer's will be featured, his installation *Vectorial Elevation* performed in a public square in Mexico in 2000, and *Underscan* conducted in November of 2008 following the author's *Memory Cloud* installation in Trafalgar Sq., London.

Figure 7: Memory Cloud, Trafalgar Square, London, England (2010)

Memory Cloud is based on the ancient practice of smoke signals – one of the oldest forms of visual communication. Fusing ancient and contemporary mediums, Memory Cloud creates a dynamic hybrid space that communicates personal statements as part of an evolving text, animating the built environment through conversation.

The second chapter ***Human Machine*** builds on the experiments of the first chapter and expands the concept of participation by shifting attention from explicit human agency towards the development of machines that could exhibit their own agency. If within the first chapter ***Human Human*** the installations focused on the design of systems to collect, synthesize and amplify human interaction; ***Human Machine*** looks to explore non-human agency through robotic experiments that exhibit the capacity to express their own behavioural features. This chapter focuses attention on exchanges between humans and machines interacting within an environment. It is in this chapter that these behavioural machines will be argued to build on their capacity to communicate through their life-like characteristics. Kinetics, illumination and sound are design features that are explored in authored experiments that construct complex interaction models that are emotive and shared between human and non-human agents. Unlike previous installations featured in the first chapter that initiated participation through willful contributions, design experiments featured in this chapter such as *Becoming Animal* and *Petting Zoo* examine environments where no distinction between human and non-human agents are made. Attention in this chapter focuses on communication and how that evolves through intuitive interactions and experience in-between agents. Building on works such as the *Colloquy of Mobiles* developed by the cybernetician Gordon Pask and the sculptural works such as *Senster* of Edward Ihnatowicz, these research experiments looked towards constructing open spatial environments that actively explore what John Johnston has discussed as "machinic life."[21] Life-like attributes, real-time emotive responses and human projective tendencies enable a complex network of relationships that operate through curiosity, wonder and the desire for understanding. Emphasis in this chapter looks towards intuitive exchanges

21 Johnston, John, 'The Allure of Machinic Life: Cybernetics, Artificial Life, and the New AI', The MIT Press, 2008.

that are learned through direct engagement and evolve through interaction. Highlighting an open framework for participation that Ihnatowicz describes as the pursuit for all "cybernetic art is, by its very nature, immediately accessible, so much so that children are its most appreciative spectators." [22] The research attempts to explore these life-like characteristics and examine how our empathy and emotive engagements with things opens up the opportunity to establish new models of relations and interactions between the animate and inanimate. Neuroscientist and cyberneticist Valentino Braitenberg in his seminal publication *Vehicles* discusses these tendencies in his introduction titled *Let the Problem of the Mind Dissolve in Your Mind*, where he states "We will talk only about machines with very simple internal structures, too simple in fact to be interesting from the point of view of mechanical or electrical engineering. Interest arises, rather, when we look at these machines or vehicles as if they were animals in a natural environment. We will be tempted, then, to use psychological language in describing their behaviour. And yet we know very well that there is nothing in these vehicles that we have not put in ourselves. This will be an interesting educational game."[23] This educational game that Braitenberg mentions within this thesis oscillates between the design and engineering of these machines and the performativity and behavioural interactions that emerge through the choreography of humans and these machines within an environment. Like other cybernetic experiments exploring systemic models of the brain, such as Walter Grey Walter's *Tortoises,* the experiment fully is enacted in a spatial scenario that evolves over time.

22 Ihnatowicz, Edward. Brochure. Self published by Edward Ihnatowicz in 1986.

23 Braitenberg, Valentino. Vehicles: Experiments in Synthetic Psychology. Cambridge, Massachusetts: MIT Press, 1984.

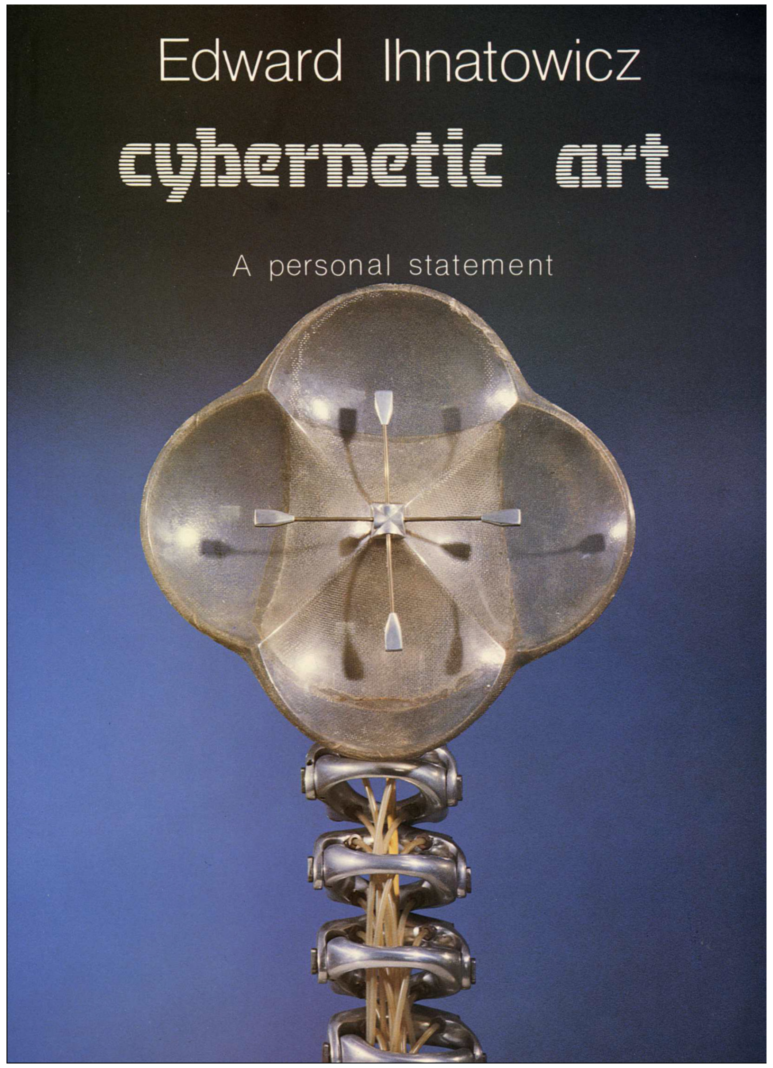


Figure 8: Edward Ihnatowicz, Cybernetic Art: A Personal Statement

Self-published pamphlet that Ihnatowicz's published as a reflection and critique of his works, implications of art and technology and the challenges he sought ahead for this arena of work.

First attempts within this thesis to develop this systemic response were developed in a work titled *Becoming Animal* where three back projected artificial creatures responded and interacted with participants. Communication in this project was facilitated through activity, orientation, illumination, colour, and gestural mesh deformation. Each back projected creature exploiting for the first time within this thesis a vision system through camera tracking that allowed each creature to recognise participant activity, number of participants and durational mapping of their engagement. If the first chapter focused on machines as recording and archiving instruments, experiments within this chapter bring about issues of artificial intelligence, behavioural design and real-time environments.

Becoming Animal brought about an immediacy of the now, as communication was durational and time dependent through the systems capacity to recognise and react to participants or other agents. This real-time interaction and artificial construction of observer features within these artificial constructs opened up exciting questions within the thesis on the subject of agency and the observed agency within interacting systems.[24] The project was an attempt to work through the implications of non-human gestural (facial) creatures that could construct a framework that could evolve over time through conversational engagements between things. *Becoming Animal* within this thesis can be seen as a transitional experiment. Through the design and development of this project the design of behaviours and method of testing their response as circular feedback opened up new conceptual and design challenges that formalise themselves in this thesis' concluding experiment *Petting Zoo*.

24 The attempts for potential users to be become active participants rather than passive observers due to the two-dimensional projection of the setup was further facilitated by the making of individual masks that served as an enabling device for active engagement with the projection heads and each other. The mask served as a device to liberate psychologically the animate the habitual behavior typical within traditional art environments.

Figure 9: Becoming Animal (2007)

The objective of the piece was to create an environment of performance through collective participation. Each participant's presence stimulates the three heads of the Cerberus, triggering behaviour-based interactions and exchanges. Interactions are expressed through sounds, facial expressions and general activity of the Cerberus. The continued dialogue between users and the system demonstrates emotive exchanges that exhibit love, anger and boredom.

Figure 10: Petting Zoo (2014) Barbican Centre, London, England

In the form of suspended robotic arms 'Petting Zoo' (2013) is a generative robotic installation populated by inquisitive and artificially intelligent creatures, which respond to human engagement. Using a real-time camera-tracking system that can locate people and detect gesture and activity each pet has the capacity to process data so that they can learn and explore different behaviours by interacting with the public and each other.

Petting Zoo evolves the research within a framework that engages real-time environmental response and emotive sensory communication through the development of fully formed four-dimensional behavior-based robotic creatures (Orleans / Barbican Centre). The *Petting Zoo* evolves the emotive and engaged communication in the spirit of the seminal cybernetic sculpture by Edward Ihnatowicz called *Senster*. In the form of suspended robotic arms *Petting Zoo* is a generative robotic installation populated by inquisitive and artificially intelligent creatures, which respond to human engagement. Using a real-time vision system that can locate people and detect gesture and activity each pet has the capacity to process data so that each pet can learn and explore different behaviors by interacting with the public and each other. Over the course of an installation or exhibition these "personalities" will be informed through their human and non-human interaction enabling intimate and immediate exchanges that are playful, emotive and evolving. Advancing the capacity to recognize and react to participants within 2D projective works like *Becoming Animal*, *Petting Zoo* brought about design challenges that were spatial and sensitive to gesture, duration and time. Petting Zoo posed challenges that beyond simulation implicated the design of software and hardware that were in synchronicity. The designs of behaviors were adaptive and learned through situated engagement. These robotic creatures evolved through informed interactions allowing each pet to create complex behavioral "personalities" as a product of interaction over time. Within the development of the *Petting Zoo* the project moves beyond projective reactive models as conceptualised by Braitenberg towards simplified artificial intelligent agents that had there own internal representations of interactions with human participants and other creatures. This concluding experiment explores gesture and behavioural response through autonomous robotic creatures that evolve their own behaviours through grafting their responses with that of their observed interactions of human agents. Beyond representational thought experiments illustrated in Braitenberg's fourteen *Vehicles, Petting Zoo* exhibited real-time behaviours that communicated aggression; intimacy and playfulness that nurtured sustained engagement with participants. *Petting Zoo* has been in varied spatial environments such as self-contained room at the FRAC Centre to the central public courtyard of the Barbican Centre in London each offering insight to their engagements with human participation that will be expanded on in further detail within this chapter.

The third chapter ***Machine Machine*** within in this thesis examines agent-based ecologies that are goal oriented through machine-to-machine interaction. If the first two chapters have focused mainly on human centric exchange, this concluding chapter explores the potential of non-human machine machine interaction. The chapter speculates on scenario-based design systems that are autonomous through behavioural forms of interaction. This framework is proposed as an alternative model that moves architecture beyond top down and bottom up spatial logics towards a model that is real-time, goal oriented and machine learned. The attempt is to argue for behavioural characteristics that have evolved through real-time experiments like *Petting Zoo* to be explored as high population agent-based systems as generators for the development of spatial environments. The primary goals with these systems is to organise and create space through two primary modes that are mobility and self-structuring. Understanding the intimate and emotive characteristics that have been demonstrated in authored experiments in previous chapters this concluding chapter speculates and builds on the behavioural characteristics in an attempt to explore if those features could be generalised as the seed model for spatial generation. This chapter explores space as an interface that could construct ecologies consisting of families of high population agents that develop fitness criteria. Distributing genetic algorithmic processes that inform their morphological

and neurological control systems synthesize this fitness criterion.

The attempt of this chapter moves architecture away from conventional models that foreground the fixed and finite towards a model of interaction that is real-time and negotiated through interaction. Cybernetician Ranulph Glanville reminds us "Intelligence is, a quality attributed by one to the other in an interaction. Intelligence requires interaction and is shared: it is found in the contribution of both participants and is held between them."[25] A behavioural architecture within this thesis challenges blueprints and master plans and articulates rather a real-time model that evolves, learns and adapts through time. This chapter will primarily feature design research on self-aware / self structuring design systems that I have led in my design lab at the Architectural Association School Design Research Lab over the last six years. The research work will look to scale the systemic features articulated throughout this thesis through abstraction in an attempt to generalise higher population of interacting agents. This process of digital breeding and competition-based environments can be clearly illustrated through the seminal work of Karl Sims in his papers on the subject written in the mid nineties such as *Evolving Virtual Creatures*[26] and *Evolving 3D Morphology and Behavior by Competition*[27]. Sims writes that "In natural evolutionary systems the measure of fitness is not constant: the reproducibility of an organism depends on many environmental factors including other evolving organisms, and is continuously in flux. Competition between organisms is thought to play a significant role in preventing static fitness landscapes and sustaining

25 Glanville, R. (2001) 'An Intelligent Architecture', Convergence: The International Journal of Research into New Media Technologies June 2001 7: 12-24

26 K.Sims, 'Evolving Virtual Creatures', Computer Graphics (Siggraph '94 Proceedings), July 1994, pp.15-22.

27 K.Sims, 'Evolving 3D Morphology and Behavior by Competition', Artificial Life IV Proceedings, ed.by Brooks & Maes, MIT Press, 1994, pp.28-39.

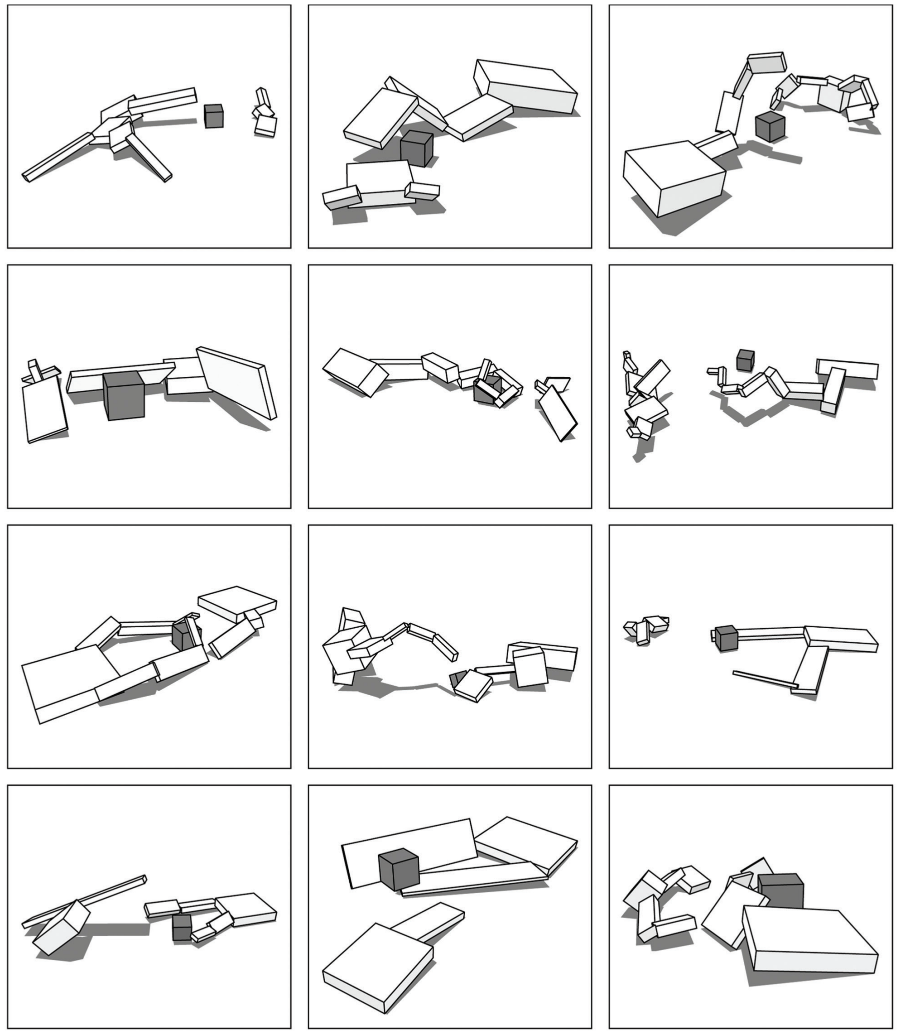


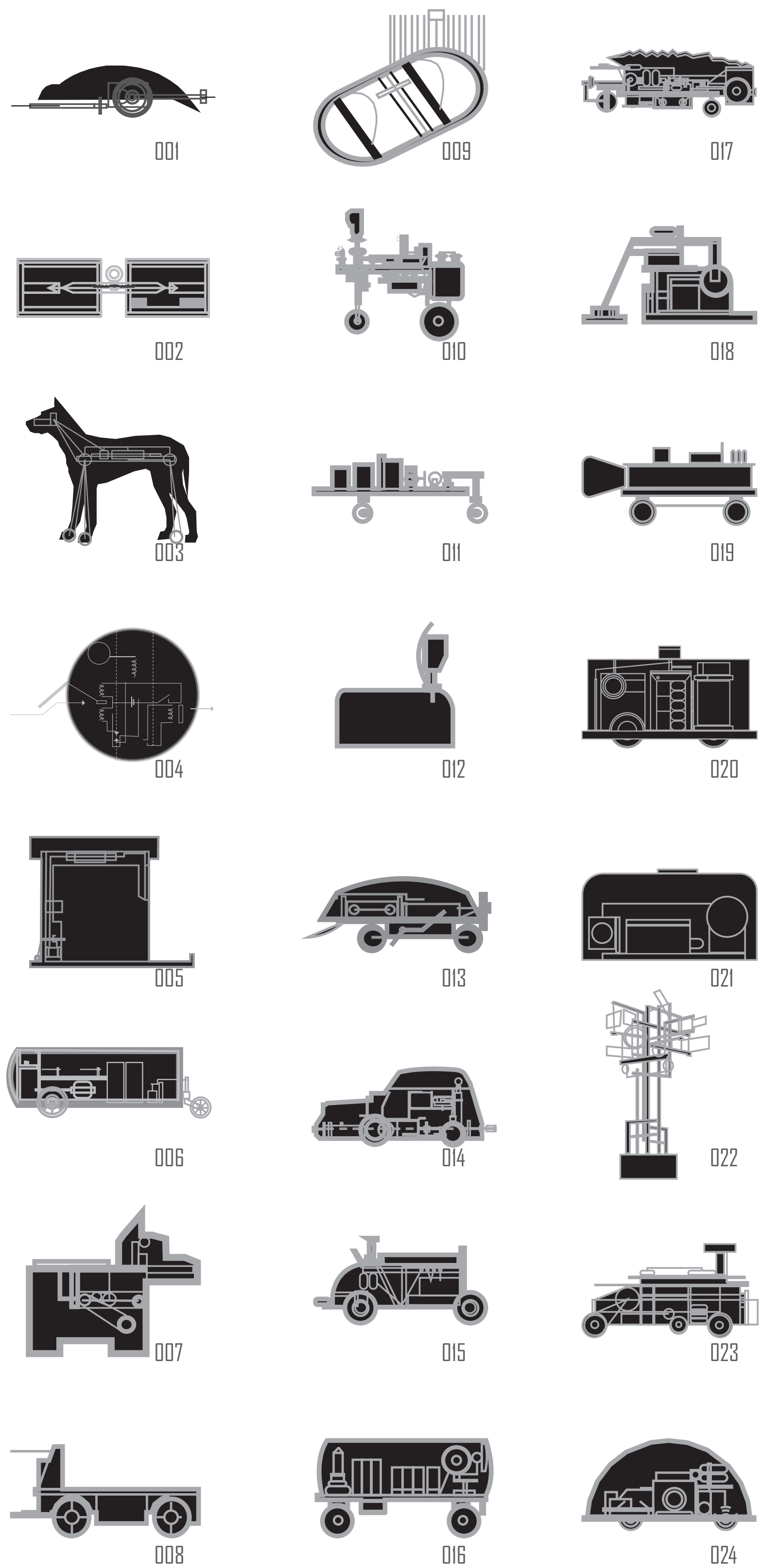
Figure 11: Karl Sims, Evolved Competing Creatures (1994)

Frame sequences of simulations of evolved morphologies and control systems of virtual creatures.

evolutionary change."[28] Organization within the research is understood through body plan generation that at a local level evolve low-level goals; for example first order organizational strategies for mobility. Rather than privileging prescriptive models, the genetic pool evolves and tests relational and population dependent organizations that aim to perform through locomotion. This process affords a design plurality of plausible solutions, performing as a body or creature for duration of time before other higher order goals are learned. The aim of this process is to evolve creatures that have the capacity to have self-awareness and autonomy of control to allow each organization to have local and global awareness.

This evolutionary model for design examines how high populations of units could interact and through this interaction develop features that could evolve the system to be self-aware, self-structure and assemble. Goals such as mobility and self-structuring are the main drivers for this research as it stands today. Environmental conditioning, machine learning and collective building expand territories of communication that speculate real-time interaction of space as a continuous dynamic system of formations. This concluding chapter opens up the enabling framework to acknowledge the evolutions of machines capacity to have meaningful interactions with other machines. Speculations of this form of engagement date back to mathematician John von Neumann's thought experiments in the late forties on a kinematic model for a physical self replicating machines to more contemporary research by Nissan with their self-parking robotic office chairs. Enabled through programmable matter, actuated soft robotics and embedded sensing technologies behavioral complexity offers new terms of reference for architecture. Architecture of the future present will engage us, challenge us and enable a new species and taxonomies of proto human machine ecologies.

28 Ibid. pg



001 Toy Beetle
Adolph Wigel, 1911

002 Electronic Dog Seleno
Meissner/Hammond, 1912

003 Wireless Dog
Steinbrook, 1916

004 Protozon
Lux, 1920

005 Electric Dog
Christian Berger,1915

006 The Electric Dog
Hugo Gernsback, 1923

007 Philidog
Henri Piraux, 1928

008 Endomechanics
Dussaud, 1934

009 Sowbug Schematic
Tolman, 1939

010 Elmer & Elsie
Grey Walter, 1948

011 Palomilla Moth
Wiener Wiesner Singleton, 1949

012 Cora
Grey Walter, 1950

013 Tinius the Cybernetic Turtle
Rice University, 1950

014 Cybercar Toy
1950

015 Squee
Edmund C. Berkeley, 1951

016 Cybernetique Tortue
Paul-Alain Amouriq, 1951

017 Miso, Job, Cesare, Barbare, Renard,Albert
Ducrocq, 1952

018 Unknown Robot
MIT, 1952

019 Tim Turtle
Kubanoff, 1953

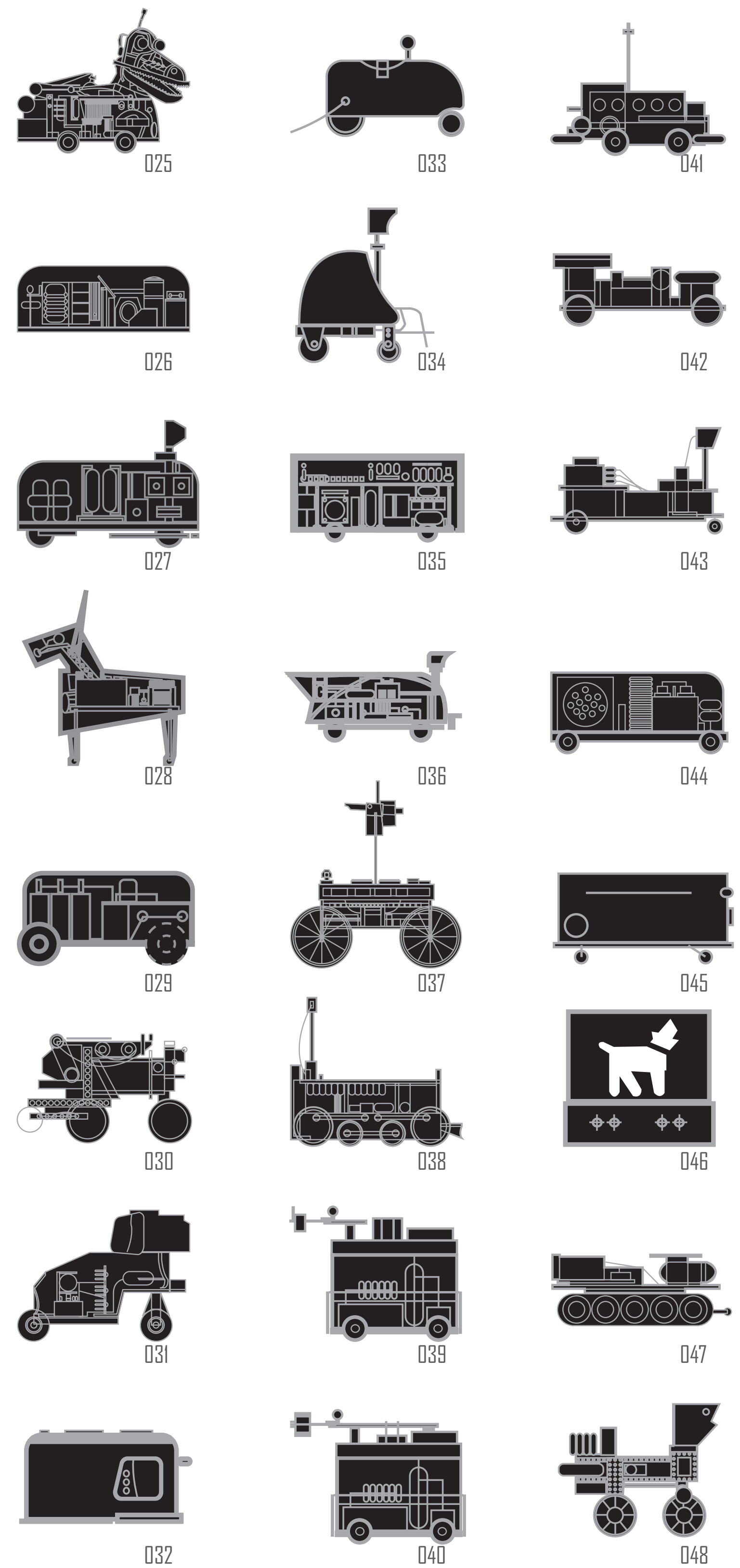
020 Vienna Turtle
Eichler/Zemanek, 1954

021 Phototropic Snail
Cross, 1955

022 CYSP-1
Nicolas Schoffer, 1956

023 Machina Versatilis
Ivan Sutherland, 1957

024 Szeged Katica
Daniel Muszka, 1956



025 Tati
Dan Dennett, c1950s

026 Beta
Vasilev/Petrovsky, 1957

027 Machina Reproducatrix
Angyan, 1958

028 Cyber the Dog
A.H. Bruinsma, 1958

029 Sparky
Welker, 1958

030 Conditional Probability Computer
Trolley-Uttley/Andrew, 1958

Tortilla
Electronical Insititute in Kiev, 1958

031 Azor/Super Azor Dog
Wojciechowski, 1958

032 Cybernetic Tortoise
Sverdlovsk, 1959

033 Cybernetic Mice
Mullard, 1959

034 Cupel
Andrzej Harland, 1959

035 Machina Combinatrix
Kretz/Angyan/Zemanek, 1959

036 Russian Cybernetic Tortoise
Unknown, 1960

037 Stanford Cart
James Adams et al. 1960s

038 Ferdinand Mod I
APL-Johns Hopkins University, 1961

039 Beast Mod II
APL-Johns Hopkins University, 1961

040 Beast Mod II - Extended
APL-Johns Hopkins University, 1961

041 Stella
John Andreae/Peter L. Joyce, 1962

042 Tortilla 2
Uknown, 1962

043 Icarus
Orr, 1962

044 Hinz & Kunz
Otto Walter Haseloff, 1962

045 Conditioned Cybernetic Machine
Cautela/Mikaelian 1963

046 Cybernetic Dog
Fred Chesson, 1963

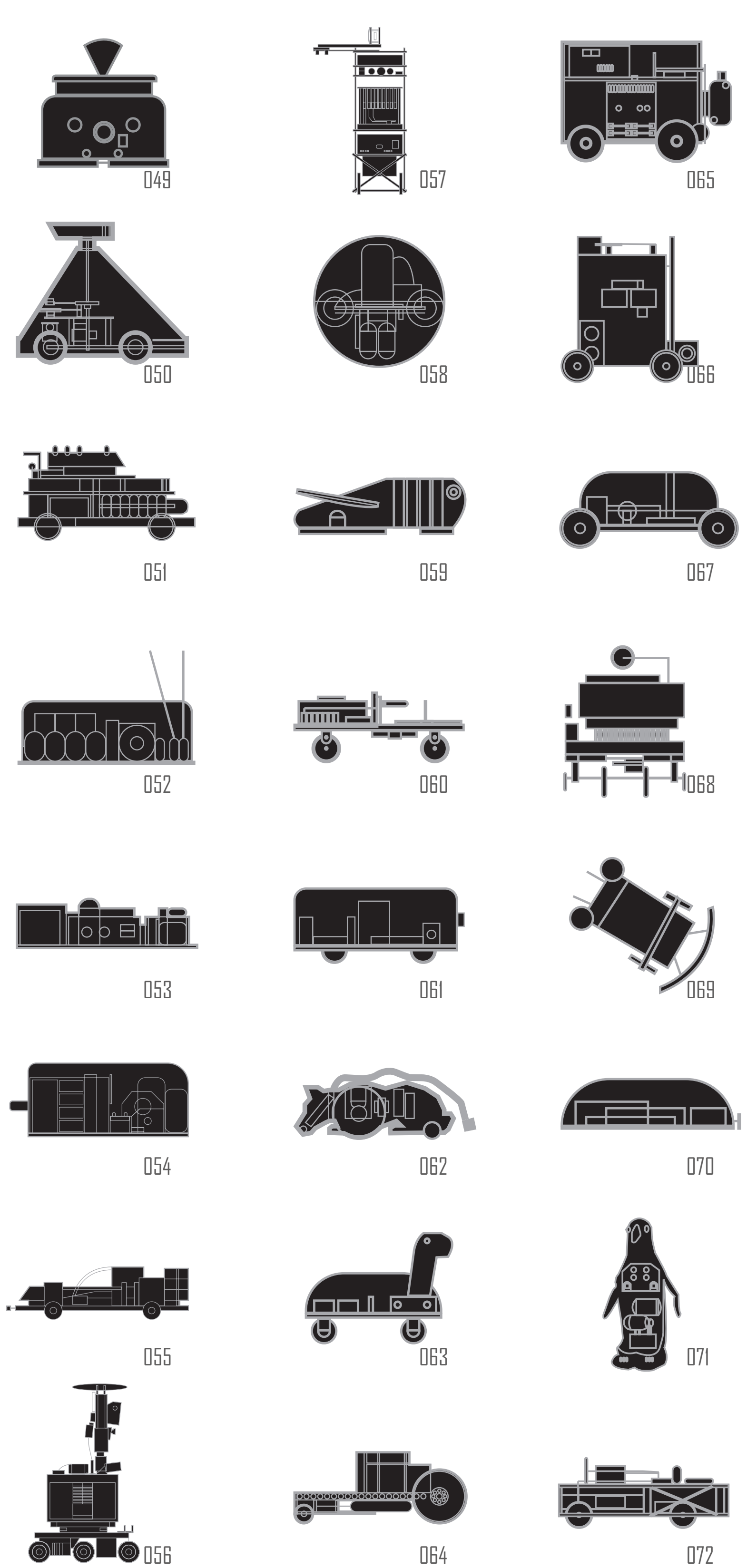
047 Omega
R. Oettel, 1964

048 Cybernetique Tortue
Armand Delsemme, 1964

049 Robug
Hans Moravec, 1964

Figure 12: Cybernetic Robots

Timeline of autonomous robotic agents based on Reuben Hoggett's Creature timeline.



050 Fred
John Holland, 1964

051 Zemanek-Schildkrote
Hans Bielowski, 1965

052 Russian Tortoise
Unknown, 1965

053 Russian Dog
Unknown, 1965

054 Russian Cybernetic Explorer
Unknown, 1966

055 Kybernetisches
Demonstrationsmodell Schildkrote
Otto Von Guericke University, 1966

056 Shakey
Rosen/Nilsson/Raphael, 1967

057 Mate
Bruce Lacey, 1967

058 Toy-Pet Plexi Ball
Parkinson/Martin, 1968

059 Russian Cybernetic Bee
Unknown, 1968

060 Cybernetic Mouse
Johan de Boer

061 Astor
Aston University, 1969

062 Russian Dog Follows Cable
Unknown, 1969

063 Russian Tortoise
Unknown, 1969

064 Emma
G.C. Brown, 1969

065 MERV
Peter Vogel, 1970

066 Russian Tortoise
Unknown, 1970

067 Xee
G.C. Brown, 1971

068 Cyclops
L.C. Galitz, 1972

069 Free Roving Machine
M.F. Huber

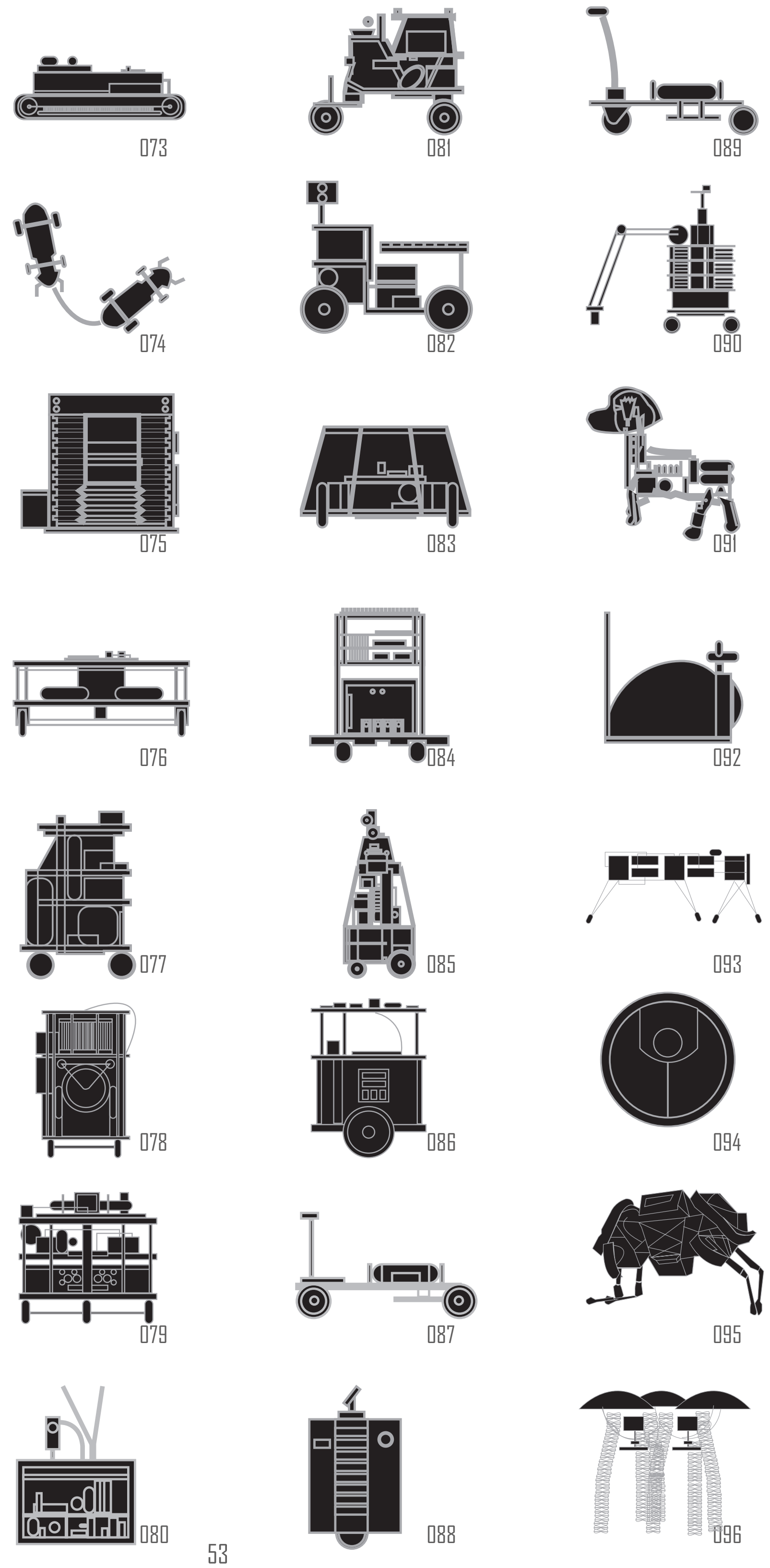
070 Cybernetic Penguin
Unknown, 1972

071 TAIR
Amosov, 1972

072 Beetle Construction Model
Unknown, 1975

073 Kytron
Rudolf Mittelman, 1975

074 Moth Model
Unknown, 1975



075 Buster Robot Animal
Heiserman, 1976

076 Mike/Microtron
Tod Loofbourrow, 1976

077 Entropy
Gene Oldfield, 1976

078 Newt
Ralph Hollis, 1977

079 Hilare
Unknown, 1977

080 QMC Mark-IV
Witowski/Mott, 1978

081 An Inexpensive Turtle
Michael Folk, 1978

082 Tee Todler
Allen/Rossetti, 1978

083 Robot Pet
Frank DaCosta, 1979

084 Hebot I, II, III
John FitzGerald, 1979

085 Rodney
Heiserman, 1979

086 Robart-I
Bart Everett, 1980

087 Superkim Meets ET-2
D.F. McAllister, 1980

088 Flakey
SRI

089 Moth
Gene Oldfield, 1984

090 Herbert
Brooks et al. 1987

091 Cybernetic Dog
Myasum Alyautdinov, 1988

092 Electronic Life Form
Tony Ellis, 1996

093 Genghis
Rodney Brooks, c1988

094 Roomba
iRobot, 2002

095 Big Dog
Boston Dynamics, 2005

096 Petting Zoo
Minimaforms, c2005

Figure 13: Cybernetic Robots

Timeline of autonomous robotic agents based on Reuben Hoggett's Creature timeline.

HUMAN HUMAN

Towards a Participatory Model for Design

Architecture in this chapter is explored through the construction of cybernetic frameworks, pursuing design that can enable engaged, durational and evolving interrelationships between man, machine and their constructed environment. The research projects within this chapter focus on "human" participation and communication. The **Human Human** section of this thesis evolved through an active engagement with design interventions that were conceived as observable environments. Through these installations it became apparent early in this thesis that there was a great deal of potential that could be discovered by shifting attention towards human behaviour and exchanges as they evolved over time through interacting with the intervention as well as with other participants. Participation, enabling and experience opened up an approach to create and evaluate how design environments could actively participate and stimulate communication. Emphasis was placed on how design can be instrumentalized to allow for human behaviour to heighten engagement and interaction through conversation and social scenarios. This thesis maintains that participation and behavioural response are fundamental in progressing our relationships with things and each other. At the heart of the framework argued here is a desire to allow agency in things to co-construct environments that afford communication-allowing systems the capacity to adapt and evolve through interaction.

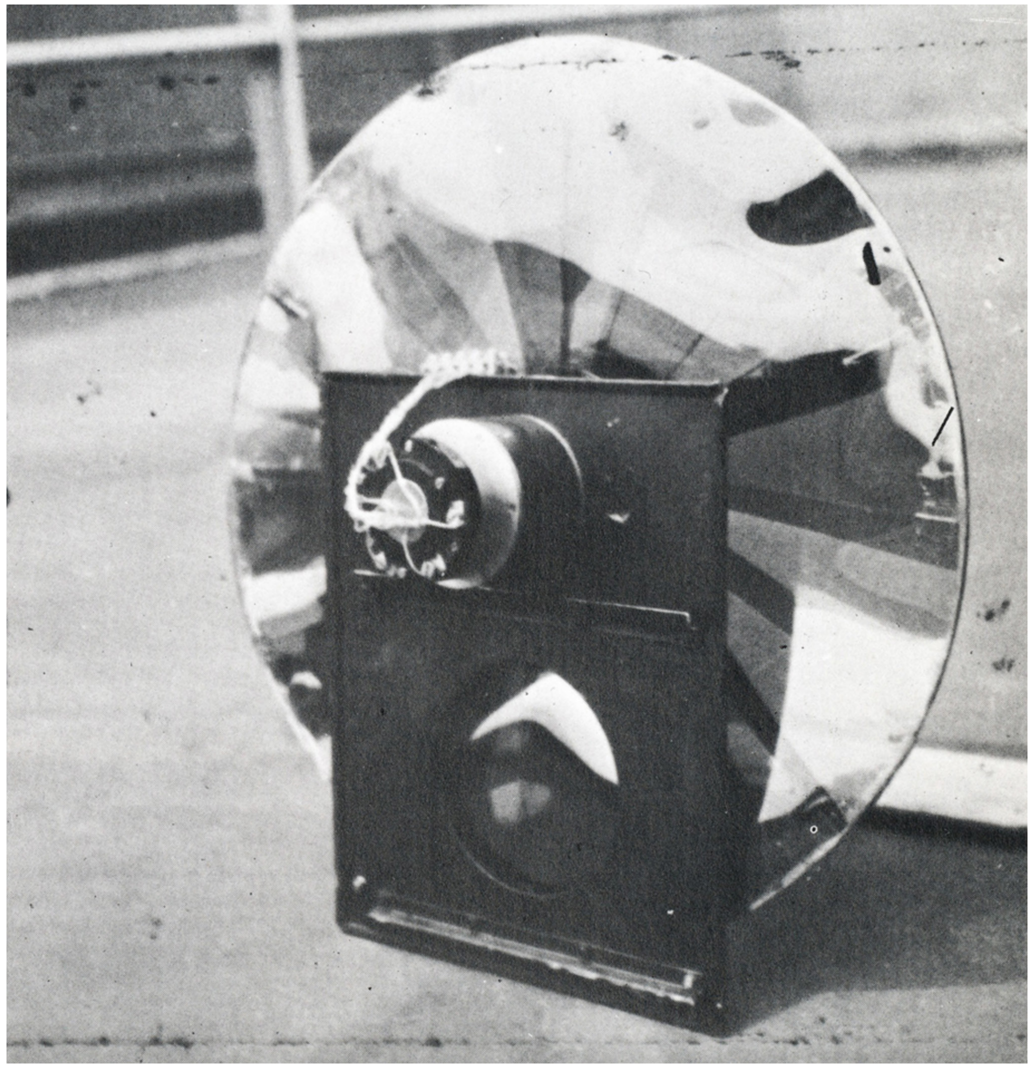


Figure 14: Gordon Pask in collaboration with Robin McKinnon-Wood: Musicolour

Servo Controlled projection wheel of Musicolour (1953-57)

Conversation theory as expressed by second-order cybernetician Gordon Pask has played an important role building on a rich history of evolving relations between man and machine within cybernetic, conceptual, computational, kinetic, and light based experiments. Exploring these conversational partnerships the research examines design as a cybernetic process and construction that enables a shared and collective model of interaction. Distinctions are made between reactive and interactive engagements. In my work there is an emphasis on interactive engagements that sustain novelty and afford the opportunity to share and communicate this desire with others. This capacity to share and communicate can evolve into understanding and means of learning. The pursuit of this trajectory of research inherently critiques many of the reactive graphic forms of interfacing today that have flattened and limited interaction to simple cause and effect triggers that do not capture the emotive and behavioural characteristics of participants. It also critiques the tendency to collapse rather than spatialise our interfaces. Society has embraced this communication revolution over the last fifty years and the information culture and communication that were born from it. It is important to recognize that architecture played an important role in this revolution. A direct example can be argued through MIT's Architecture Machine Group, which was founded by the architect Nicholas Negroponte and who researched with his collaborators over a ten-year period evolved into the well-known MIT Media Lab. Many of the radical architects of the sixties and seventies moved away from finite ideas of building towards ephemeral constructs and nomadic technological infrastructures that dissolved architecture into framework of communication.

As this revolution has become our everyday the opportunity is to consider how architecture can participate today and evolve the current scenario as a spatial medium for interfacing. The act of participation throughout this research looks to

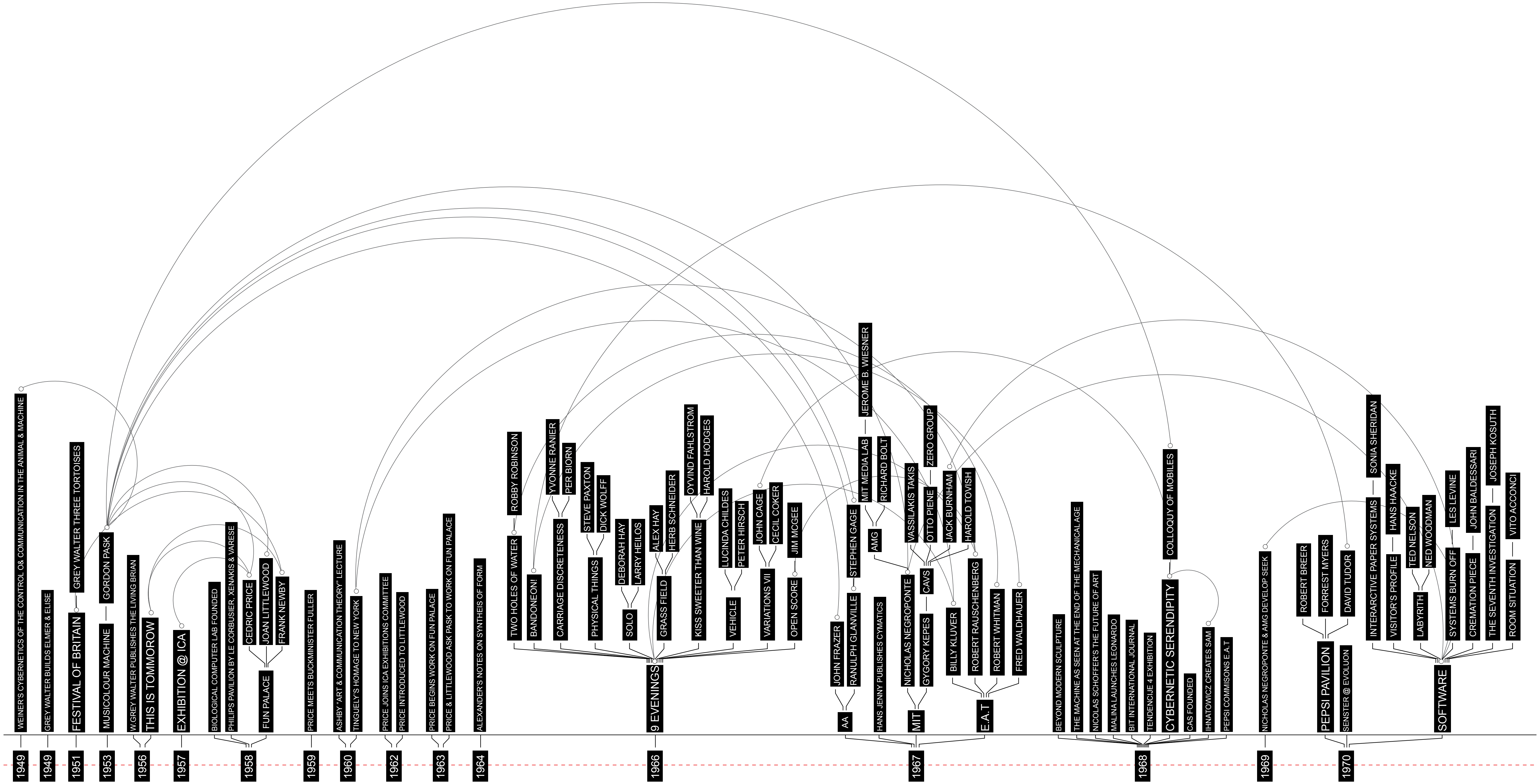


Figure 15: Cybernetic Timeline of Key Historical Moments

Timeline outlines key events from 1949 – 1970 that influenced the thinking and historical precedence of this thesis.

how formal or informal strategies could be enacted within a particular context. The thesis argues for participation that privileges second order cybernetic feedback, allowing for complex interactions to arise through human agency and the observed agency of these interactions. Attention is placed on behavioural features that afford conversational rich exchanges between participant and system, participant with other participants and or systems with other systems.[1] These exchanges as will be seen evolve over time and shift behaviour from conventional passive observation towards active participation. Participation within these environments can be understood through sustained durational exchanges, context related or situational response and understanding.

Design, which is at the heart of this research, is itself explored as Ranulph Glanville defines as an "iterative, recursive, reflective and clearly cybernetic act.[2]" The act of designing frameworks as environments for understanding lends itself to a series of design considerations in conceiving, materialising and externalising these relationships through cybernetic feedback. Scenario and evolving time based forms of interactions construct an approach towards real-time experiments that serve to demonstrate aspects of cybernetic exchanges that allow for discovery, curiosity and play to articulate the motivation of a systemic pursuit that denies tendencies for explicit control towards exchanges that are conversational and by their nature evolving over time. These conversational and emotive exchanges offer an adaptive model that embodies properties identified in Pask's attributes of "aesthetically potent environments." Pask states that these would operate as "environments designed to encourage or foster the type of interaction

1 Please note that this text, written by the author of this PhD, was first published in Behavioural Complexity: Constructing Frameworks for Human-Machine Ecologies. Archit. Design, 86: 36–43. doi:10.1002/ad.2022, 2016.

2 Glanville, R. (2007), Designing Complexity. Perf. Improvement Qrtly, 20: 75–96. doi: 10.1111/j.1937-8327.2007.tb00442.x

which is (by hypothesis) pleasurable. It is clear that an aesthetically potent environment should have the following attributes:

A. It must offer sufficient variety to provide the potentially controllable novelty required by a man (however, it must not swamp him with variety—if it did, the environment would merely be unintelligible).

B. It must contain forms that a man can interpret or learn to interpret at various levels of abstraction.

C It must provide cues or tacitly stated instructions to guide the learning and abstractive process.

D It may, in addition, respond to a man, engage him in conversation and adapt its characteristics to the prevailing mode of discourse." [3]

The research is motivated in re-examining the second order cybernetic project as a model for developing a framework for a collective, adaptive and shared behavioral environment. As information rich environments and human machine interfacing are rapidly progressing so to is the need to explore new models of interaction that are spatial and participatory, moving beyond screen based systems towards models of spatial interfacing that are emotive and shared. A designed environment developed within this research explores scenarios that enable human curiosity and play, forging intimate exchanges that are emotive and evolving over time. Contributions by participants are observed as a medium for involved interaction. Externalization of these interactions constructs complex

3 Pask, Gordon, 'A Comment, a Case History and a Plan', in J Reichardt, Rapp and Carroll (eds), Cybernetic Serendipity, 1970, reprinted in J Reichardt (ed), Cybernetic Art and Ideas (London: Studio Vista, 1971), p 76.

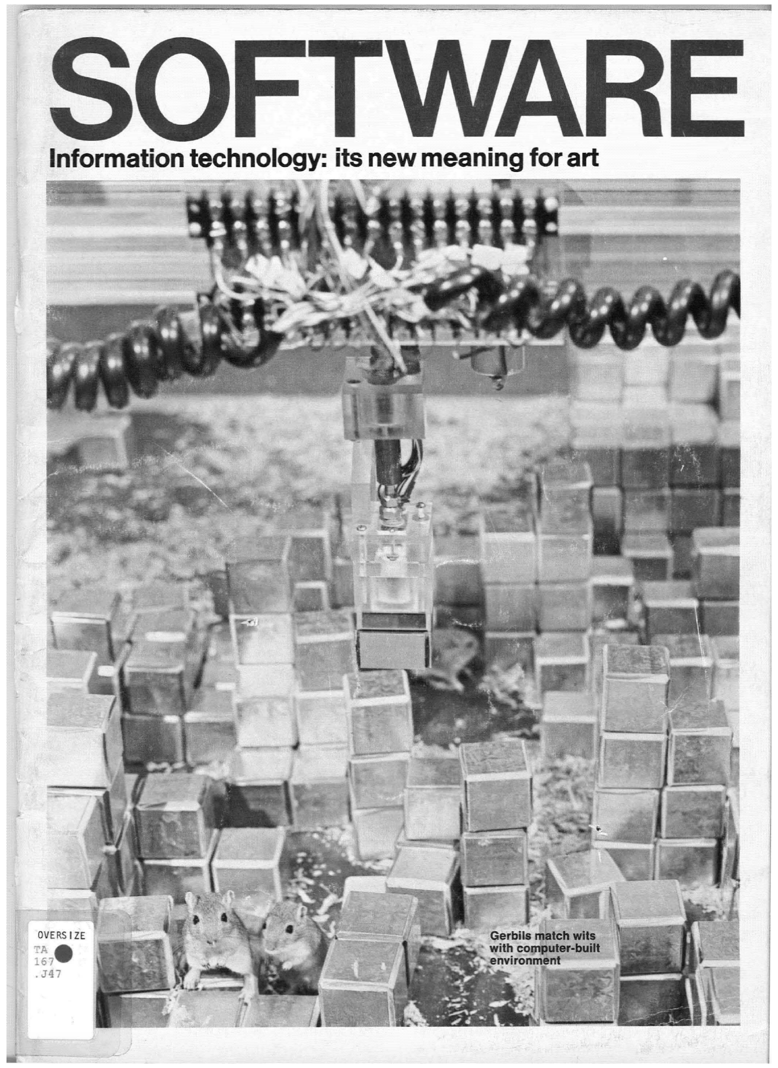


Figure 16: Exhibition catalog of “Software”, The Jewish Museum, New York 1970

On the cover of the exhibition is The Architecture Machine Group’s contribution titled Seek, to the 1970, exhibition.

set of relationships between the individual and the collective. Conversational partnering can manifest in the form of dynamic and intuitive relationships between the environment, active observers and performers within the system. This form of interaction constructs a framework to explore space as a model of interfacing that shifts the tendencies of passive occupancy of space towards an active and evolving ecology of interacting objects.[4] The research moves away from the fixed and finite models of space that reinforce habitual responses towards an understanding of space as an active agent for communication and exploration. Time and durational qualities evolve a dialogue between things that examines exploration and learning through forms of serious play. Play will be argued to afford a speculative and open approach towards understanding and acting within an environment that will form an important enabling device for participation. Through direct experience participants’ initial novelty evolves into enquiry and constructive understanding. Through this dialogue between things our behavioral environment can be experienced as intelligent. Intelligence Ranulph Glanville reminds us in his paper *An Intelligent Architecture, “is experienced by us.”* He continues, “ from individual instances we have observed: that is, we observe, we generalize (find pattern) and we create the concept of intelligence, which we then both modify as we go, and allow to determine whether various acts and behaviors we observe are intelligent or not.” [5] Founder of the Architecture Machine Group and the MIT Media Lab Nicholas Negroponte in the introduction of his first publication *The Architecture Machine: Toward A More Human Environment* stated in a similar spirit to Glanville that “intelligence is a behavior. It implies the capacity to add, delete from, and use stored, information. What makes this behavior

4 Please note that this text, written by the author of this PhD, was first published in Behavioural Complexity: Constructing Frameworks for Human-Machine Ecologies. Archit. Design, 86: 36–43. doi:10.1002/ad.2022, 2016.

5 Glanville, Ranulph .(2001) An Intelligent Architecture Convergence: The International Journal of Research into New Media Technologies vol.7 no.2: pg.2

unique and particularly difficult to emulate in machines is its extreme dependence on context; assessment if such meaning is an intelligent act.” [6] Within this research designed installation environments are developed in an attempt to construct experiments that operate as open frameworks to explore durational and participatory features, privileging experience and shared interaction. The move towards a spatial and conversational model of interaction pursues a definition of an intelligent architecture in the spirit that Glanville has defined. “Intelligence depends on the interface of our interaction.”[7] The challenge posed is to construct environments that are shared between participants and afford communication.

In considering the principle key themes that give legibility to the approach of this research I will outline the consistent features that play a fundamental role in constructing attempts towards identifying participatory model(s) of interaction through enabled forms of communication between the design environment and participants. Environments in this thesis are argued as a spatial, durational and context aware set of constraints that allow for the design, development and observable overview of the research experiments to be understood. The means towards enabling will be explored as a move in-between, arguing for an understanding and shared form of interaction that evolves through participation; dissolving conventional dichotomies of user (singular or collective) and system.

Enabling

A key concept within this thesis is the stimulus that affords sustained and novel engagements of participants within an environment. Many of the research installations authored in this thesis have been designed as publically accessible

6 Negroponte, N. (1973) The Architecture Machine: Toward a More Human Environment. Cambridge, Mass: The MIT Press. Pg. 1

7 Ibid pg. 8

interventions within urban spaces and museum contexts, which typically privilege habitual and passive observation. Through design the installations are structured to shift from passive to active engagements that afford more curious and exploratory stimulus. The concept of enabling extends beyond direct stimulus of an individual and looks towards behaviours that situate the singular within the collective. The communication capacity to express through these installations affords observers stimulus to contribute to an evolving dialogue within this environment. This dialogue is between and amongst participants with in a human-to-human framework. Enabling within the context of these works shifts passive observation towards potential and active participation. The installations within this thesis have been designed with a purposeful lack of instructions outlying explicit rules of engagement, which brings about issues of design accessibility, allowing for more intuitive means to engage the work and most importantly themselves. Human Human frameworks are scenario driven and situational.

Making Things Personal: The Value of Contributing

Within **Human Human** frameworks active participation is enabled through personal contributions. *Facebreeder* and *Memory Cloud* are two authored experiments that explore the immediacy of participant behaviour exhibited through the active and wilful contribution of portraits in *Facebreeder* and SMS messages in *Memory Cloud*. The act of contributing personal and identifiable contributions within a framework offers conversational rich exchanges between observers, participants and performers within the shared environment. The design systems in both projects operate as instruments for enacted human engagement. The capacity to identify ones contribution within a shared spatial experience within an installation format created social scenarios that further stimulated participation.

Figure 17: Face Breeder Capture Device

Participants would contribute their portraits as part of an evolving archive that would be displayed in a 3x3 matrix of screens.

Figure 18: Memory Cloud, Trafalgar Square, London, England 2008

Participants seek legibility in their projected messages and sustain an interest through playful observation and interaction with other users in a shared spectacle.

Exploring environments through situational means allows for immediate and responsive interactions that are intuitive and emotive to evolve. Installations within this thesis have the potential through sustained curiosity to become operative tools of expression and communication. The participant engages as an active observer and performer constructing an understanding through direct experience that animates and stimulates further engagements. Personal and collective stimulus allows for continued means to explore and engage the installation and each other. Elements of theatrical wonder can be expressed in examples such as in Gordon Pask's proposal for a cybernetic theatre where he writes, "I am fascinated by the consequences of a participant system and the wealth of dramatic situations which can be woven in a such a fabric.[8]" Interaction lends itself towards situational influences and control, as Gordon Pask argues, "A dramatic presentation is thus a control system.[9]" As all the research experiments are public installations the role of observer principals as well as the role of the participant performer will be expanded in the two research projects featured in this chapter.

Time Based Constructs: Towards Ephemerality

Constructing immediate or short-term participatory environments, unlike pursuits for a timeless and autonomous architecture examines an immediate form of architecture that makes demands that shift the finite and fixed relations typical in the built environment towards design systems that are evolving, relational and ephemeral. Within this domain architecture is confronted with novel forms of materiality, information and duration that move beyond geometry and objectification towards proto-architectural systems as conversational partners.

8 "Proposals for a Cybernetic Theatre", privately circulated monograph (System Research Ltd and Theatre Workshop), 1964, p.3.

9 Ibid. p.7.

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This conception does not impose itself on inhabitants but enables them to participate in defining their own environment. One of the attributes of a short term framework is its ability to acknowledge and respond to immediate and evolving relationships with users, responding as works of Cedric Price have acknowledged to inhibiting, restrictive and obsolete tendencies of the built environment that render it incapable to evolve. Immediate environments instigate change as a means to foster and encourage discovery and novelty. Architecture here could be understood as the construction of change, evolving causal and circular relationships that are in continual formation. In this thesis there are no blueprints or master plans only self-structured laws of correlation that allow architectural systems to evolve and adapt through interaction. Architecture in this context seeks to stimulate and actively construct open frameworks that allow for users to creatively participate and influence the behavioural attributes of the environment. Cybernetic and behavioural features are articulated as means to identify qualities of experience and interaction that construct the terms of a participatory model for architecture. Architecture moves towards open-ended systems that are engaged with revealing a process of becoming as they continually construct a reciprocal coupling of people and things.

Understanding and or Novelty and the Pursuit of Control

Exploring environments through situational means allows for immediate and responsive interactions. Installations within this thesis have the potential through sustained curiosity to become operative tools of expression and communication. The participant engages as an active observer and performer constructing an understanding through direct experience that animates and stimulates further engagements. Personal and collective stimulus allows for continued means to explore and engage the installation and each other. Elements of theatrical wonder can be expressed in examples such as in Gordon Pask's proposal for a cybernetic theatre where he writes, "I am fascinated by the consequences of a participant system and the wealth of dramatic situations which can be woven in a such a fabric.[10]" Interaction lends itself towards situational influences and control, as Gordon Pask argues, "A dramatic presentation is thus a control system.[11]" Control within this thesis will challenge the first order cybernetic explicit command and control objectives. Control within this research is not finite but something shared between agents. Control within these systems is relational and collective. Summarized succinctly by second order cybernetician Gordon Pask when he states, "When learning to control or to solve problems man necessarily conceptualizes and abstracts. Because of this, the human environment is interpreted at various levels in a hierarchy of abstraction. These propensities are at the root of curiosity and assimilation of knowledge. They impel man to explore, discover and explain his inanimate surroundings.[12] Addressed to the social environment of other men, they lead him into social communication, conversation and other modes of partially co-operative interaction."[13] Unlike formal methods of abstraction of the past that simplified the world of operation, architecture here problematizes and delves in the rich complexities that spatial practice enables. Unlike arguments of animate form and key framed simulation spaces that form illustrative process driven representations of the world the architecture here examines time as medium of awareness and communication. Behavioral complexity is argued as an approach today that engages new forms of interaction that are social, material, and environmental. The model moves away from forms of representation towards models of demonstration that is motivated by creating

10 "Proposals for a Cybernetic Theatre", privately circulated monograph (System Research Ltd and Theatre Workshop), 1964, p.3.

11 Ibid. p.7.

12 Please note that this text, written by the author of this PhD, was first published in Behavioural Complexity: Constructing Frameworks for Human-Machine Ecologies. Archit. Design, 86: 36–43. doi:10.1002/ad.2022, 2016.

13 Pask, Gordon, 'A Comment, a Case History and a Plan', in J Reichardt, Rapp and Carroll (eds), Cybernetic Serendipity, 1970, reprinted in J Reichardt (ed), Cybernetic Art and Ideas (London: Studio Vista, 1971), p 76.

possibilities rather than singular solution spaces. The goal is constructing a behavioural synthesis that sees complexity residing in relationships between things rather than attributes to things.[14]

An emphasis in this research is placed on conversational and participatory models of interaction in an attempt to address possible parameters that could articulate the terms of an immediate architecture. Conversation understood as the most primal and everyday form of communication will be used to demonstrate forms of interaction that are not prescriptive and allow design the capacity to evolve relationships with observers as participants. Conversational models can allow designers to re-articulate a human centric form of design that does not look to anthropomorphic arguments of the past that centre on proportion and form (i.e. the classical definition of the Vitruvian man or the modern ideal of the modular of Le Corbusier) but rather on the adaptive and behavioural aspects of human interaction. The finite and fixed attributes of object related definitions are shifted towards cybernetic approaches that privilege dynamic and evolving relationships.

Conversational partnerships rely on the ability to maintain novel engagements, as actions are voluntary and shared. This identifies a critical question in considering where does the newness in a system reside? For adaptive properties of a system to exist, variety and variation are key parameters in identifying novelty through change. Participants enable this evolution through pursuits of communication and control. This articulates one of Gordon Pask's central arguments that can be examined in what he terms 'aesthetically potent environments.' Although described by Pask as an environment that is to foster pleasurable interactions, he recognised the importance of externalising these

14 Please note that this text, written by the author of this PhD, was first published in Behavioural Complexity: Constructing Frameworks for Human-Machine Ecologies. Archit. Design, 86: 36–43. doi:10.1002/ad.2022, 2016.

interactions (discourse) through an understanding of the novel. He states that 'Man is prone to seek novelty in his environment and, having found a novel situation, to learn how to control it.[15]' The issue of control enables 'man' potential action. Man can in his own interaction with an environment, stimulate and enable further interaction through his ability to assimilate new forms of knowledge. Control here is not explicit as first order cyberneticians were primarily interested in, rather control from a conversational perspective is something structural coupled for duration in time. Bernard Scott, a long time collaborator and co-author with Pask articulates this distinction from a Paskian perspective when he asks, ""What is learning, what is knowledge? When considering what learning is and how it occurs, it is useful to recall that humans, like all other biological organisms, are dynamical, self-organising systems, surviving - and evolving - in a possibly hostile world. Such systems survive by adapting to their worlds and by actively becoming "informed" of how their worlds work. "Learning", as biological adaptation, happens incidentally in the context of the pursuit of current "need-satisfying" goals. "Learning" as a process of adaptation is going on all the time. One cannot not learn. In humans, learning finds its highest expression. Our "need to learn" is so strong, we experience boredom and actively seek out novel environments.""[16] Novelty, control, learning and knowledge are correlated through our human capacity to build frameworks for understanding within latent or unknown contexts. Through uncertain and curious scenarios the desire to seek novelty is apparent in the experiments discussed within this thesis underlying the cybernetic framework argued for in this thesis. Pask reinforces the systemic aspect of this framework from what can be interpreted as design when he states "cybernetics and architecture… share a common philosophy in the sense that Stafford Beer has shown it to be the philosophy

15 "A Comment, A Case History, and a Plan", in Cybernetic Serendipity, J. Reichardt, (Ed.), Rapp. And Carroll, 1970. Reprinted in Cybernetics, Art and Ideas, Reichardt, J., (Ed.) Studio Vista, London, 1971, 76-99.

16 Bernard Scott (2001). Gordon Pask's Conversation Theory: A Domain Independent Constructivist Model of Human Knowing. Foundations of Science 6 (4):343-360.

of operational research."[17] In Pask's own design research experiments like *Musicolour* developed with Robin McKinnon-Wood in 1953, he actively explored this "need satisfying" goal as their thesis in constructing this cybernetic framework hinged on the capacity to mutually co-evolve a performance as system. This framework itself was both participant and performer within a scenario specific theatrical exchange. *Musicolour* was designed to actively participate by creating atmosphere through illumination. Responding to "human" musicians by sourcing inputs of rhythm and frequency, *Musicolour* responded to the human performer and contributed to the performance with complimentary illumination values. In a symbiotic manner the musician would play and a pattern sensitive response would be exhibited through light. The performance of *Musicolour* would evolve over time through the offering of alternative patterns of sequencing light levels and intensity. The performer could it was hypothesised choose to respond and change his contribution moving the performance in a conversational manner to what one could consider a free-form jamming as common in Jazz. Pask discussed the pattern breaking as the systems boredom and thought that because the performance with *Musicolour* engaged both sonic and illuminative features that this conversational aspect in correlation could create evolving variety and novelty within the system. The regulation of variety and novelty would be controlled between participants. In this case the musician and *Musicolour*.

Cybernetics in particular from a Paskian perspective has played an important role in the design experiments explored in this thesis. My attempt in many of the experiments was to develop an installation that posed questions that could inform new forms of communication through behaviour-based design. In a project such as *Facebreeder*[18], early observations of the human aspect of dramatic situations

17 Pask G. (1969) The Architectural Relevance of Cybernetics. Architectural Design 9: pg.494

18 Facebreeder was developed in collaboration with Vasilis Stroumpakos.

Figure 19: Trafalgar Square Memory Cloud Set Up

Installation of all the equipment and systems check the day of the performance in London.

that participatory interventions could enable was directly experienced. It was in this early experiment that the observation of human agency and exchange through a simple act of contribution was observed. Over a month long period and in two different exhibition environments many of the fundamental questions that set out this thesis were asked. The richness of human exchange and the dynamics of a live experiment offered the stimulus that has been the mainstay of my development and contribution to systems thinking and making through this thesis.

Installation as Method / Making as Thinking

One of the main features of this thesis exploits installations as an observable framework to test assumptions and seek out opportunities to allow for further enabling, variety and novelty. Installations themselves have been designed as recording devices and with respect to this chapter have most explicitly archived contributions that lend themselves to further understanding of behaviour through recorded artefacts. Allowing these design systems to evolve over time and audience, gave a heightened awareness on how design systems could be influenced and how these systems could influence the behaviour of participants. The systems themselves needed to be robust and work, be designed to be accessible, communicate that they processed contributions, and allow for an open spatial engagement to observe and perform. Installations within this thesis are not representational and have been developed and installed with great care and attention. The importance of its non-representation status is paramount, as designed prototypes by necessity needed to be used and misused by participants to create the environment for operational research. For this reason making in this thesis has played and fundamental role and features strongly in the documentation of each authored experiment. It is also important to state that the installations themselves have both hardware and software development. The prototype discussed in this thesis is a digital / analogue system which has been calibrated and iterated upon in multiple contexts and testing environments.

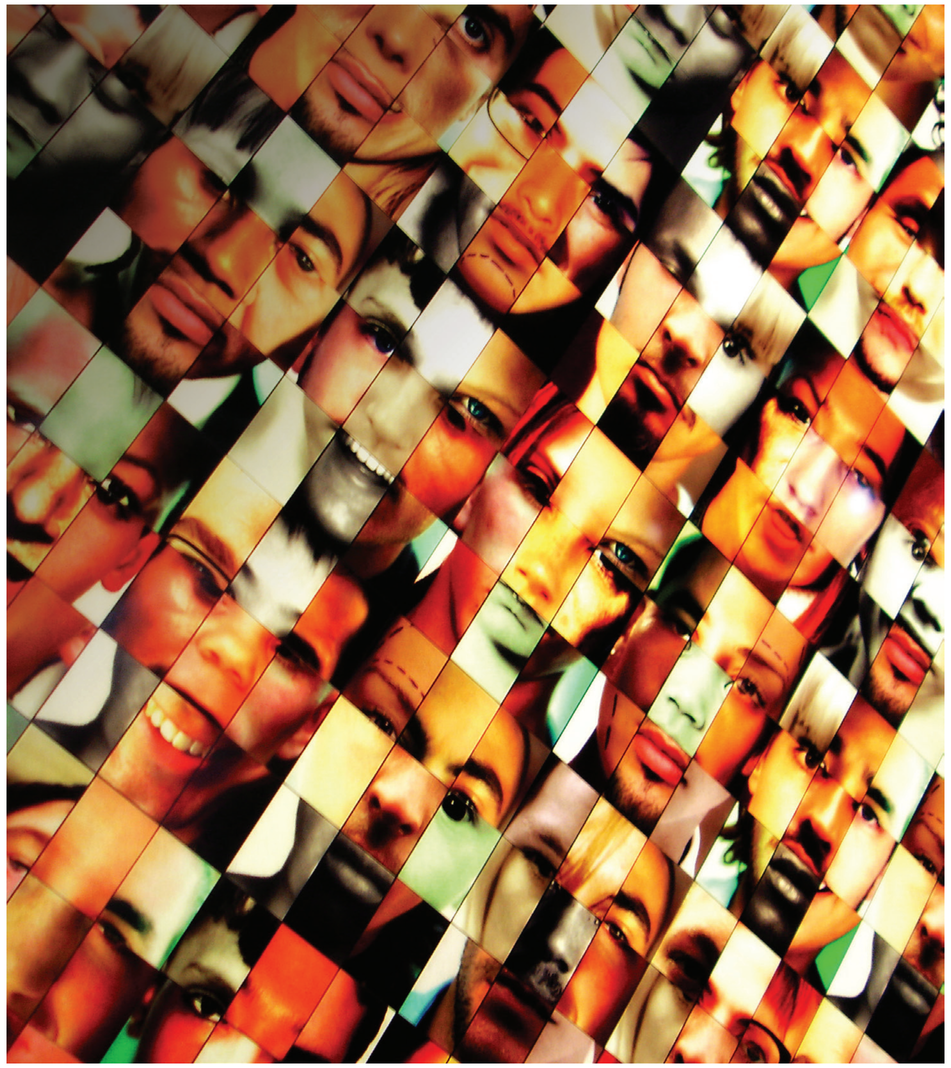

Figure 20: Facebreeder

Identity is co-constructed as engineered artefact, enabling an interface of collective expression through machinic monstrosities.

PROTOTYPING DESIGN: FACEBREEDER

Concept:

Facebreeder was developed as a response to an invitation by David Greene and Samatha Hardingham in 2004 to contribute a project as part of the London Architectural Foundation's exhibition on the theme of *Future Vision of London* exhibited in the storefront of Selfridges Department store. The concept of our proposal looked at London as a cultural hybridising machine. London here was not understood as other contributors such as Zaha Hadid or Norman Foster[19] as an object, building or master plan. Our proposal rather looked to create a machine that processed identities of individuals to create a new cultural artefact that spoke to this evolving hybridity through portraiture. Each participant in the system would contribute their identity as part of an emerging database of portraits of participants. The portraits would populate a 3 x 3 grid of data fields that would showcase a portion of the participant within this gridded interface.

19 Norman Foster as a response to the theme submitted a large master plan of his proposal for the London Olympics bid.

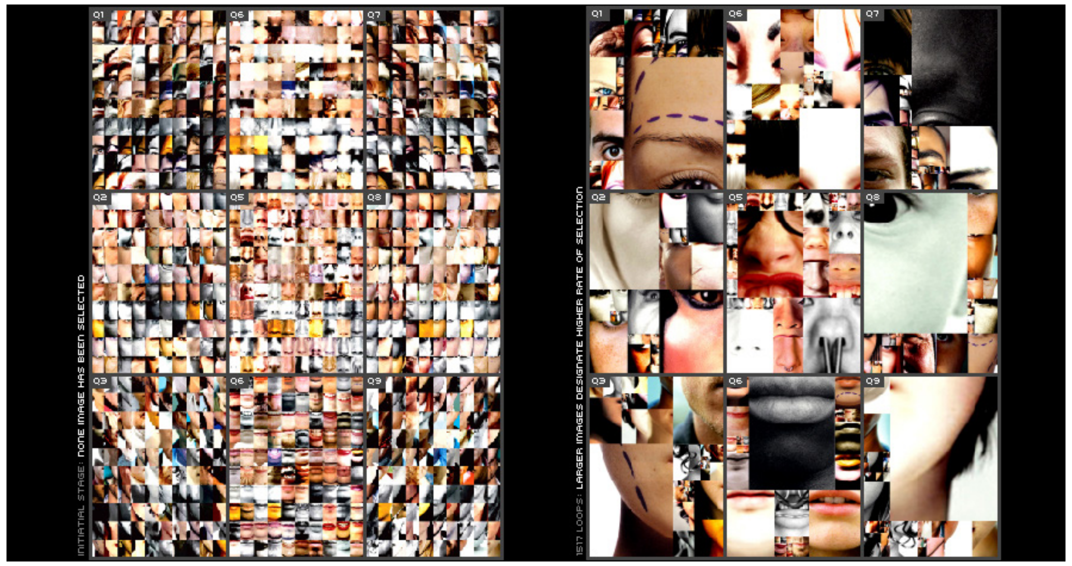

Figure 21: Facebreeder Database

Data management of all portraits contributed to Facebreeder visualized along with the frequency of their display.

Figure 22: Facebreeder, Selfridges 2004

Installation in Oxford Street storefront.

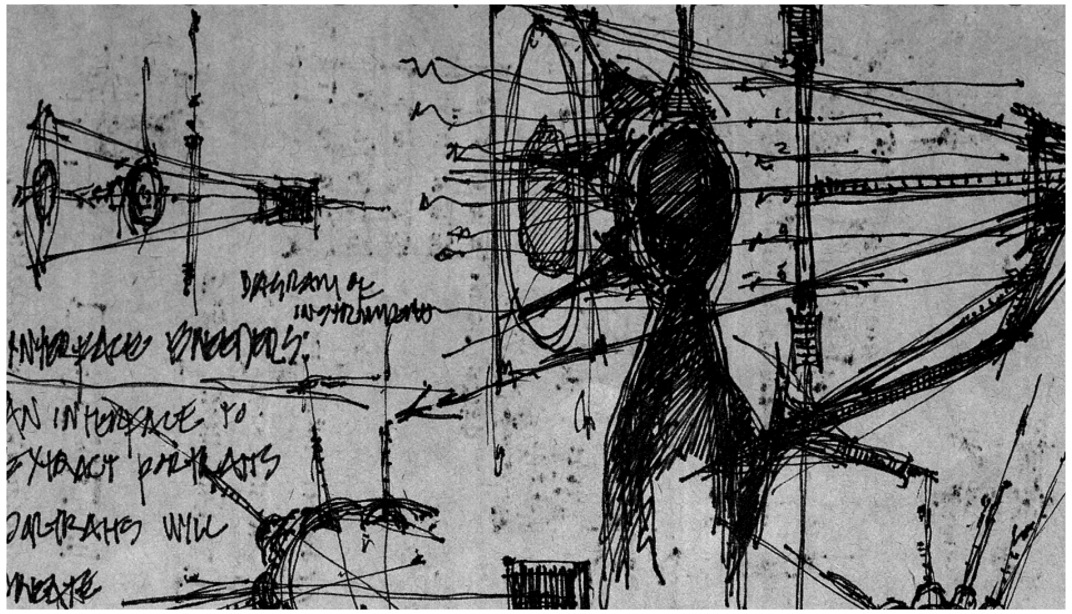

Figure 23: Facebreeder Capture Device

Initial sketch outlining the capture device developed for the second version of the Facebreeder install.

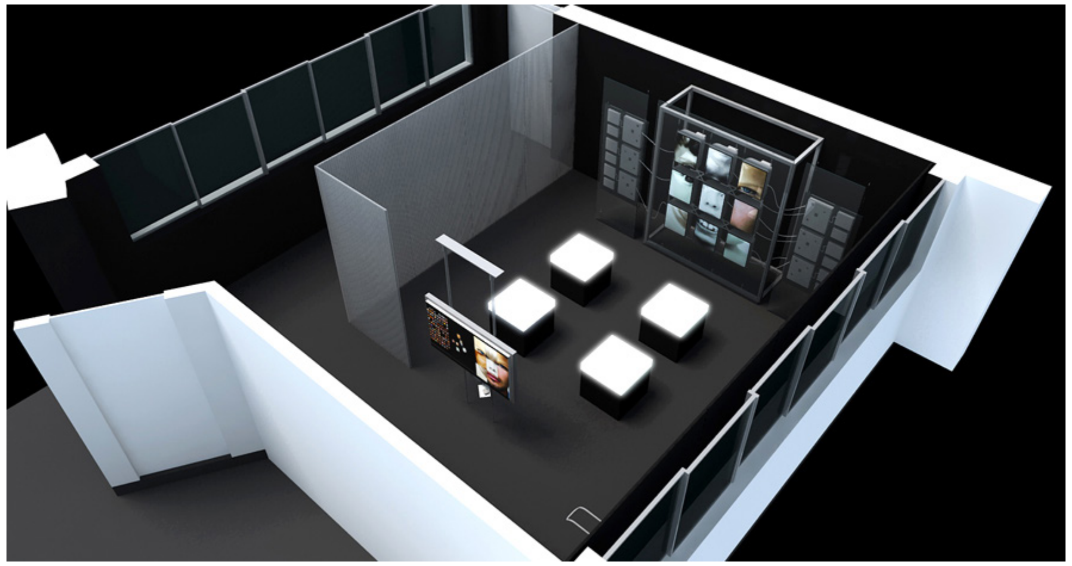

Figure 24: Facebreeder AA Exhibition Layout

Final visualization rendered of the Facbreeder installation at the Architectural Association.

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DESIGN PROCESS

Facebreeder's design process foregrounded the machine as a conceptual construct and began through the disassembly and reassembly of disused hardware (CPUs / CRT screens) that were the raw materials for this work. This process of restructuring the visual interface brought about a cultural commentary on the disposability of machines that was juxtaposed by the personal contributions of human portraits that were breed through this. This ad-hoc portrait machine constructed a hybrid assemblage through identity / portraiture mixing. Individuals offered their portrait as part of an evolving database that was populated with participants' images. This simple contribution of a portrait opened a particular understanding of the role that the personal contribution played within the installation and the larger systemic / machinic environment. As part of the invitation we were asked if we could use five-year-old personal computers that were stored in a basement of the University of Westminster. Initial struggles dealt with hardware issues that reassembled the CRT screen into a 3x3 grid display. All existing hardware had all cases and components redistributed onto Perspex sheets and tension hung fixings. The process of design continued to develop custom instruments and communication software to populate, mine and display the contributions of participants.

Figure 25: Design Process

Selection of images throughout the design and development of Facebreeder.

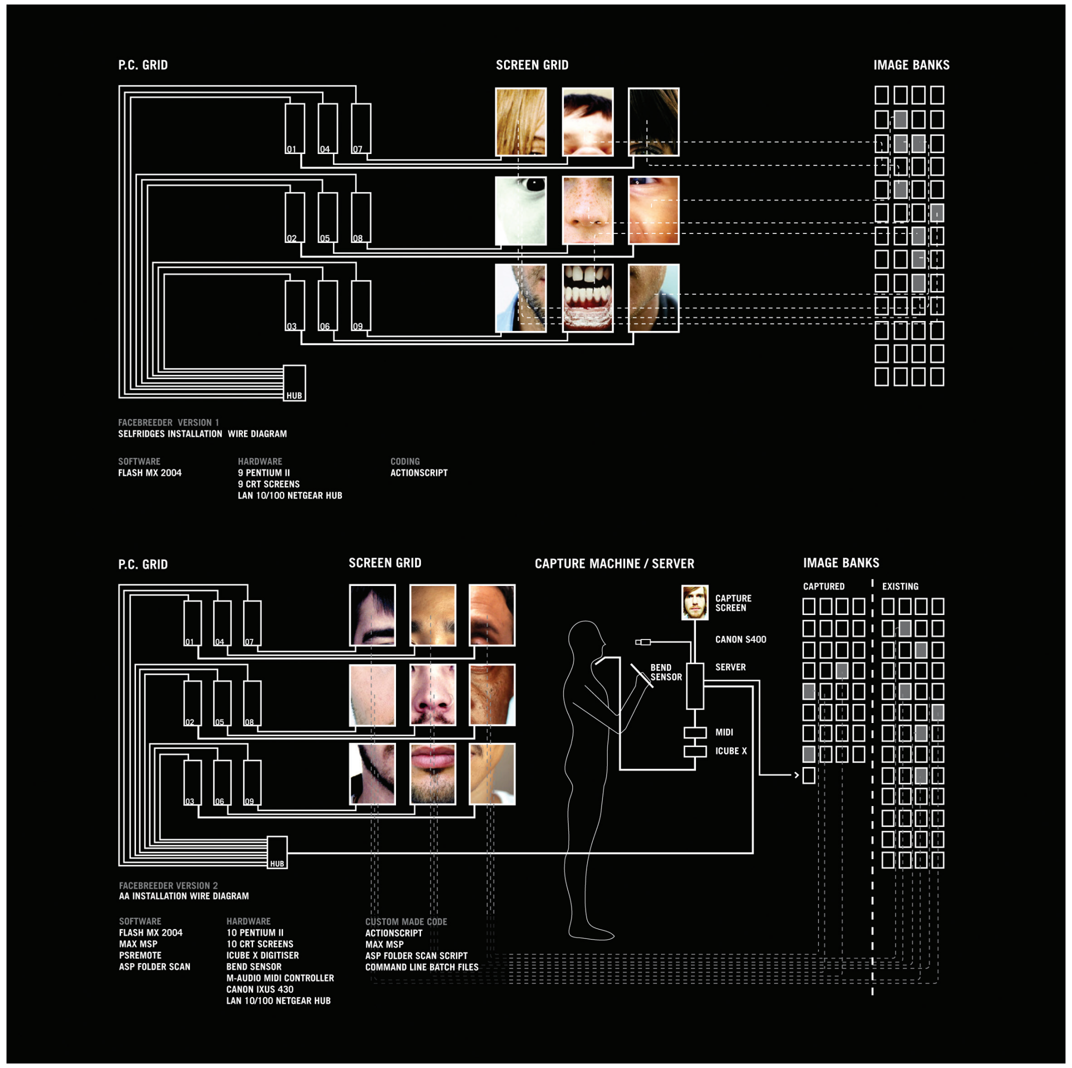


Figure 26: Facebreeder System Wire Diagram

Relational system diagrams of the two installations of the Facebreeder highlighting information flow between databases capture device and 3 x 3 CRT display.

COMMUNICATION FRAMEWORK

The contribution side depended on developing a system to capture and populate a database. The communication framework as shown in the wire diagram structured the relationships of the various components through cycles of information exchange within the installation. In the first iteration of the project developed for Selfridges' department store a participant could contribute their image using an online email capture. In the second version, which was shown at the Architectural Association later that year, participants contributed their image using a hand-actuated instrument that was installed as part of the intervention. Each participant would place his or her chin under the console that housed a bendy sensor and an image would be captured. This image would be displayed in a screen below the device and populate a database over all captured portraits. The portraits would be mined and displayed randomly on one of the nine screens that showcased the portraits. Participants could contribute as many portraits as they wanted and all would populate the database with more images. Participants would take routinely a second capture, as they may have not liked their first picture. All contributions made during this exchange were recorded as part of the system.

Figure 27: Capture Device

The capture device was developed as an instrument that would be adjustable and intuitive allowing for individual participation.

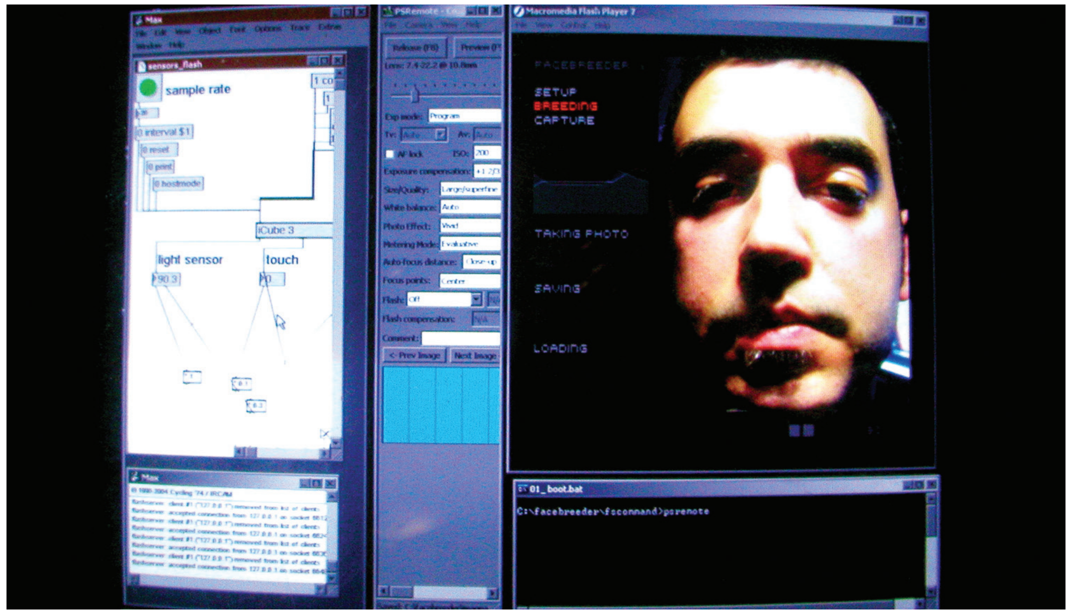


Figure 28: Capture Device Display

Using a bendy sensor, the instrument would capture an image and archive this as part of the collective databank. Below, a screen displays the captured image.

PROTOTYPING

Translating the wire diagrams into an operable prototype posed many communication and hardware challenges as information from sensor data to database development necessitated transcoding and format scripting which was due to the lack of cross platform compliance and limited coding knowledge. MaxMSP, flash communication server and other software systems of communication were made to execute the tasks that were needed. Over ten years later this communication protocol would be very straightforward but at the time there was limited if no translation between platforms that were available for design purposes. The hardware development in particular with the instrument design also posed challenges of image consistency and cropping. After multiple iterations a camera signalled system was developed that used the bendy sensor to trigger the camera and capture the image. The distance between the participants chin and the camera portion was designed to control the quality and consistency of image capturing that would allow the 3x3 grid cropping to correlate all images mined for each screen. Each screen in the display interface had separate computer mining from the database. A further online development allowed all contributions in the installation to shown and breed through an online breeding machine that remains as an online archive of the project. The online archive records all ids that are selected in the active fields by users allowing each visitor an opportunity to breed their own taxonomy of portraits.

Figure 29: Facebreeder, Architectural Association

The project evolved over two years and was installed in two locations. The first was part of an exhibition held by the Architecture Foundation in 2004 to speculate on a ‘Future Vision of London’. The second installation was part of a solo show exhibited in 2005 at the Architectural Association.

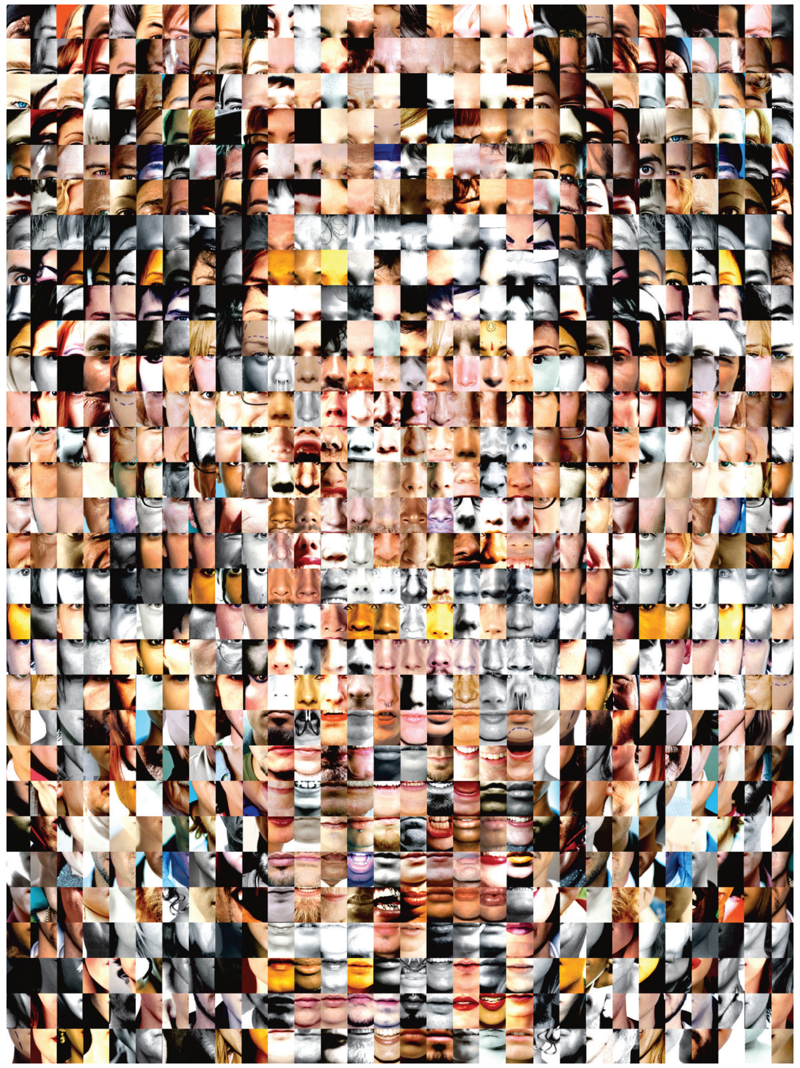


Figure 30: Breeding Machine

Participants actively observed the display, scanning the nine screens for their own image.
The anticipation of participants would be prolonged as the database increasingly grew.

OBSERVATIONS

Externalized within the installation observable responses and behaviors of participants could be elicited. Anticipation and curiosity in the relationships that participant had in seeing their image offered interesting observable engagements. The act of contributing their image to the project created an intimate relationship between the participant and the work itself sustaining a deeper and personal engagement through experience and sustained observation and involvement. The hybridized portraits that were continuously being generated within the installation environment offered a means to examine the personal response through image to be shared and reassembled within a public unfolding. The random display of images on the 3x3 grid of exposed CRT screens created a situational response for the participant to see his or her contribution within the matrix of other hybrid portraits. This over the duration of the exhibition varied as the random selection from the populated database would vary with respect to time needed for a participant's image to be selected and loaded within the matrix. The anticipatory condition of the participants desire to experience their contributed image being bred by the machine was unexpected.

The system processed images that were dynamically displayed randomly. In the first days of the exhibition the database was not heavily populated and the duration that would elapse for a participant to see himself or herself within the work was relatively short. As the exhibition continued over the month the time varied greatly. This anticipation was shared with emotive gestures of pleasure when they saw even a 1/9th of the composite image. This behavior between

Figure 31: Facebreeder, Selfridges Department Store

Photo documentation and wire diagrams explain relationships between elements at both the Selfridges and AA show.

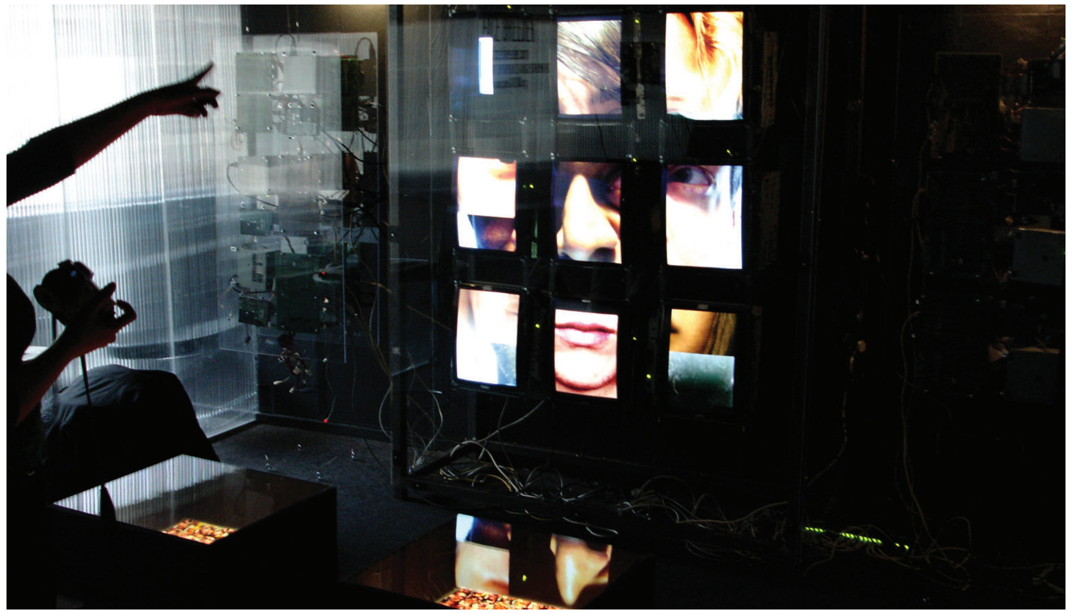


Figure 32: Facebreeder, Architectural Association

Portraiture allowed a direct form of communication that enabled participants to directly engage with their portrait and the hybridisation that was a product of the facebreeding machine.

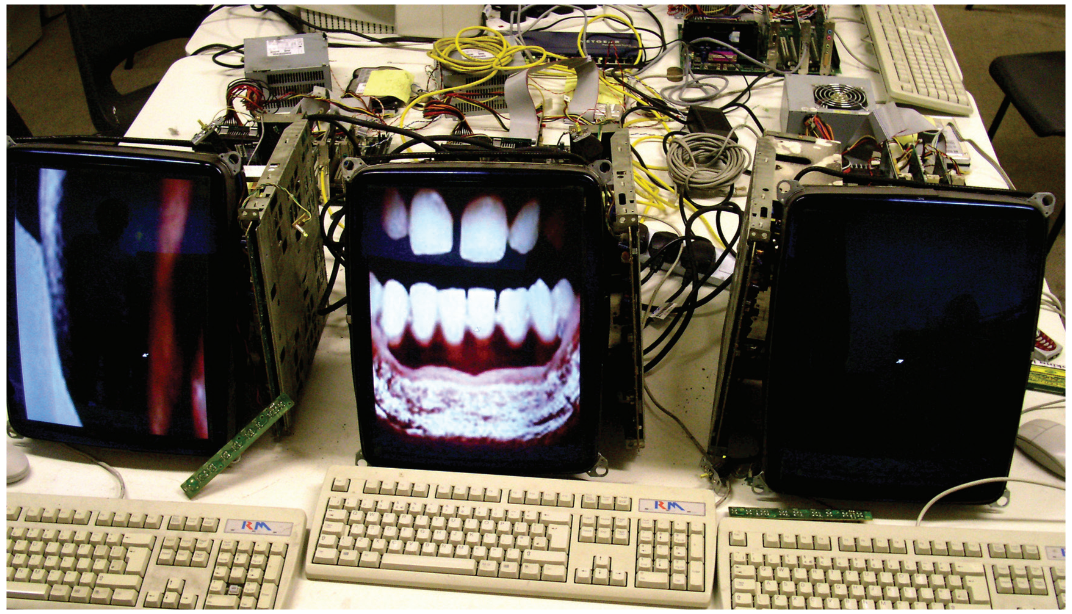


Figure 33: CRT Interface Display in Progress

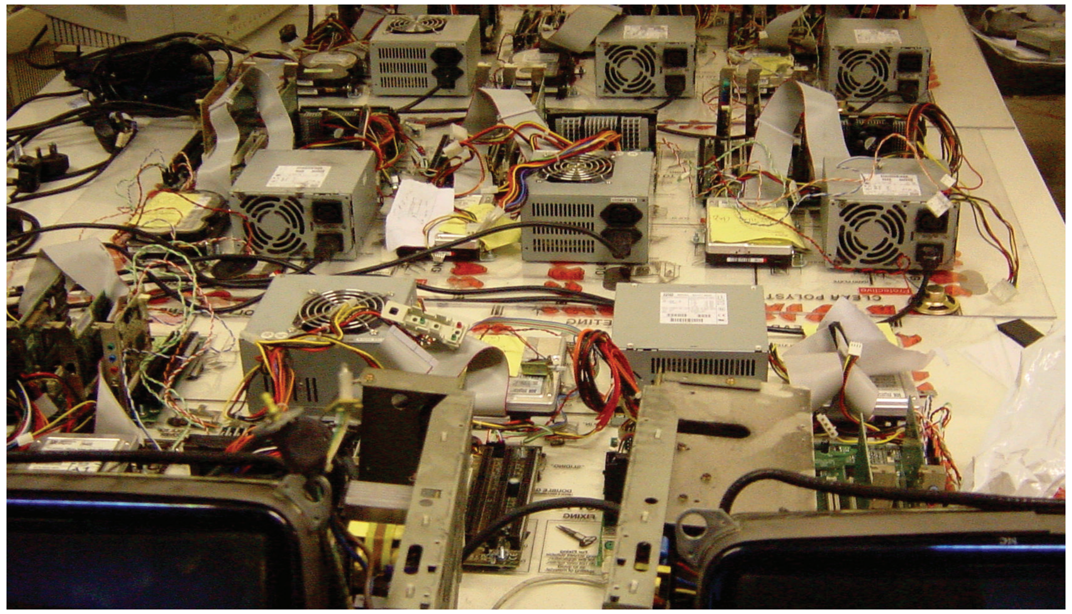


Figure 34: Component Disassembly

participants as the observed the portraits became a conversational talking point. Recorded sequences of contributions demonstrated playful means in which users attempted to influence the system within the constraints of the setup.

Animating the Built Environment Through Conversation

We can communicate – that is, combine and reinforce our knowledge with that of other men – by stimulating the circulation of ideas and feelings, finding channels of communication that can interconnect our disciplines and enable us to see our world as a connective whole.

György Kepes, Structure in Art and Science, 1965[20]

The late 1960s and early 70s saw the rise of research groups, exhibitions and publications that explored new concepts of cross-mediated constructions in art and architecture, science and technology. In 1967, as the culmination and institutionalisation of many of these early initiatives, two famed research departments were established at MIT: the Architecture Machine Group, founded by Nicholas Negroponte, ostensibly set up to explore the relationship between architecture and computation; and the Center for Advanced Visual Studies, run by the Hungarian-born artist and theorist György Kepes as a platform for investigations into art and technology. In the same year, engineers Billy Klüver and Fred Waldhauer and artists Robert Rauschenberg and Robert Whitman created Experiments in Art and Technology (EAT) as an association to couple art and engineering practices. This in turn was followed a year later, in 1968, by the publication of Franco-Hungarian sculptor Nicolas Schöffer's cybernetic manifesto, La Ville Cybernétique, the founding of the British Computer Arts Society and two key exhibitions exploring the role of the machine and technology in art and science – 'Cybernetic Serendipity' at the ICA in

20 Kepes, G. [Editor] (1965) Structure in Art and in Science. George Braziller.

London, curated by Jasia Reichardt, and 'The Machine as Seen at the End of the Mechanical Age' at the Museum of Modern Art in New York, curated by K G Pontus Hultén.

From this, one can see that in the short two-year period from 1967 to 1969 many of the defining questions concerning systemic practice and the emergence of a cybernetic art and architecture were already being posed. Words such as conversation, interaction, interface and evolution suddenly became part of the architectural vernacular – a project language that would come to define both the experimental and the mainstream. In 1973, art historian Lucy Lippard tried to give form to this period of experimentation in art through a publication called Six years: The Dematerialisation of the Art Object from 1966 to 1972. The publication, a loose collection of chronologically organised events, statements, articles was focused on 'so-called conceptual or information or idea art with mentions of such vaguely designated areas as minimal, anti-form, systems, and earth or process art.'[21] The inability to define clear categories or description highlights the scope and diversity of the questions and practices that had emerged. Art and design became territories for intellectual interrogation, new trajectories and provocations were formed in both the conception and practice.

The role of science and technology on the practice of art and architecture would provide some of the most radical and thought provoking scenarios. In 1965 Gygory Kepes stated in his introduction to The Nature and Art of Motion that 'to structure our chaotic physical and social environment as well as our knowledge and values, we have to accept the conditions of the new scale and learn to use the tools that have grown from it.'[22] Our contemporary sensibility with regard to communication

21 Lippard, Lucy. Six Years: The Dematerialisation of the Art Object 1966–1972 (New York: Praeger, 1973), p 3.

22 Kepes, György. Structure in Art and Science (New York: G Braziller, 1965).

has evolved new sensibilities and complexity privileging mediated and remote interaction. Memory Cloud explores the role of space, in particular in regards to the physical and public environment as an agent of communication. As Kepes' New Bauhaus mentor and colleague Laszlo Moholy Nagy once proclaimed, 'Design is not a profession but an attitude…Thinking in complex relationships.'[23] British Artist Roy Ascott would reinforce this sentiment with an emphasis on the societal and cultural implications, stating that 'Great art sets up systems of attitudes which can bring about the necessary imbalance and dispersal in society whilst maintaining cultural cohesion. For a culture to survive it needs internal acrimony (irritation), reciprocity (feedbacks) and variety (change). Enter art.' The coupling of art and technology brought about a discourse that was social and optimistic. A sensibility that was shared through the belief that through innovation, new channels of communications would emerge that would interconnect what had become self contained and isolated disciplines in the cultural and scientific fields. Art was thought as a tool to actively collaborate and communicate with disciplines beyond the practice of art and design itself.

"The work is about your seeing. It is responsive to the viewer. As you move within the space or as you decide to see it, one way or another, its reality can change. The approach to it is very important. It's possible for you to make the reality of your experience of the piece become the determinant of its existence."

James Turrell, Occluded Front, 1985[24]

23 Moholy-Nagy, László. *Vision in Motion* (Chicago: 1947), p 42.

24 Turrell, James, *Occluded Front* (Larkspur Landing, CA: Lapis Press, 1985), p 15.

Figure 35: Memory Cloud

Architecture is the construction of change, evolving causal and circular relationships that are in continual formation.

PROTOTYPING DESIGN: MEMORY CLOUD TRAFALGAR SQUARE / DETROIT

Concept:

Almost 40 years after Gordon's Pask first articulated architectural systems theory, our Memory Cloud installation set out to resurrect his insistence upon communication and control. Commissioned by the ICA and installed in Trafalgar Square in October 2008, the project was presented as an 'externalised' social experiment in participatory and communicative structures. At its heart was a fusing of ancient and contemporary forms of communication – smoke signals (one of the oldest forms of communication) were re-imagined by grafting SMS messages onto plumes of artificially generated smoke so as to create a hybrid space that projected personal statements across Trafalgar Square, animating the built environment through conversation.

The installation itself was one of only four public art projections that have taken place in the Square – the first, Krzysztof Wodiczko's South African Embassy Projection (1985), was followed by Flock (2007), a 'virtual Swan Lake' by Top Sapsford and KMA (Kit Monkman and Tom Wexler), and just prior to Rafael Lozano-Hemmer's video portraiture installation, Under Scan (2008). The references and allusions within Memory Cloud, however, were not tied to the physical specificities of Trafalgar Square but instead drew heavily on the first debates and discussions surrounding cybernetic theory in the late 1960s. Central among these was a re-contextualising of Herbert Read's dismissive 'scribbles in

Figure 36: Communication Concept

Memory Cloud is based on smoke signals – one of the oldest forms of visual communication. This communication is based on an abstract system of visual code broadcast over expansive distances.

Hybridising smoke signals with mobile (SMS) texting allowed us to conceive of a system that could create a spatial interface. Through the use of projection, personal messages would be transformed as a responsive four-dimensional typographic environment.

the air'[25] critique of mid-twentieth-century sculpture. For Read the uncertainties of the 1960s produced a crisis of communication, but with Memory Cloud these same uncertainties are used to free up rather than curtail communication. Placed at strategic points around the Square, just north of Nelson's Column, seven smoke machines created an airborne fog that was in constant state of flux and re-formation. Used as the backdrop for the projection, SMS messages (as twenty-first-century scribbles) were continually reformed as the volume of fog allowed the text to change scales and incarnations along the driftscape of projected light. It was precisely the instability of this fog that made the project engaging, and allowed Memory Cloud to emerge as a medium for simultaneously communicating, broadcasting and observing.

25 Read, Herbert. A Concise History of Modern Sculpture (New York: Frederick A Praeger, 1964).

Figure 37: Memory Cloud Test, Trafalgar Square

A network of seven smoke signals created an arena of airborne projection fog that was in a constant state of formation.

HUMAN HUMAN

DESIGN PROCESS

The design of *Memory Cloud*[26] evolved through multiple iterations of live experiments installed in various venues over a period of six years. The first two experiments were titled *Smoke Signals* and served as prototypical live experiments in the development of the work. The first public iteration of the project was performed in Suffolk, U.K. as part of electronic art and music event in Bentwaters Airbase in the summer of 2006. This experiment was installed outside the Star Wars building and performed for an audience of eight hundred onlookers at the event over one hour. The project attempted to allow both local participants and online participants the opportunity to communicate through the projected atmosphere. The interface online allowed remote participants the opportunity to have real-time recorded video feed that gave them a view of the projected streams and would allow them participate in the evolving text and dialogue. Though technically the project was sound and allowed this form of engagement between local and remote audience to happen with minimal delay the intimacy and responses of the participants seemed removed. The context of this initial experiment had many challenges of a technical nature that forced us to consider remoteness in ways that became opportunities for future consideration in our next experiment. The spectacle and transformative qualities of communication in this animate form intrigued audiences and their curiosity and engagement allowed the work to enable and construct and ephemeral interface for conversation.

26 Memory Cloud was developed in collaboration with Stephen Spyropoulos under the name Minimaforms.

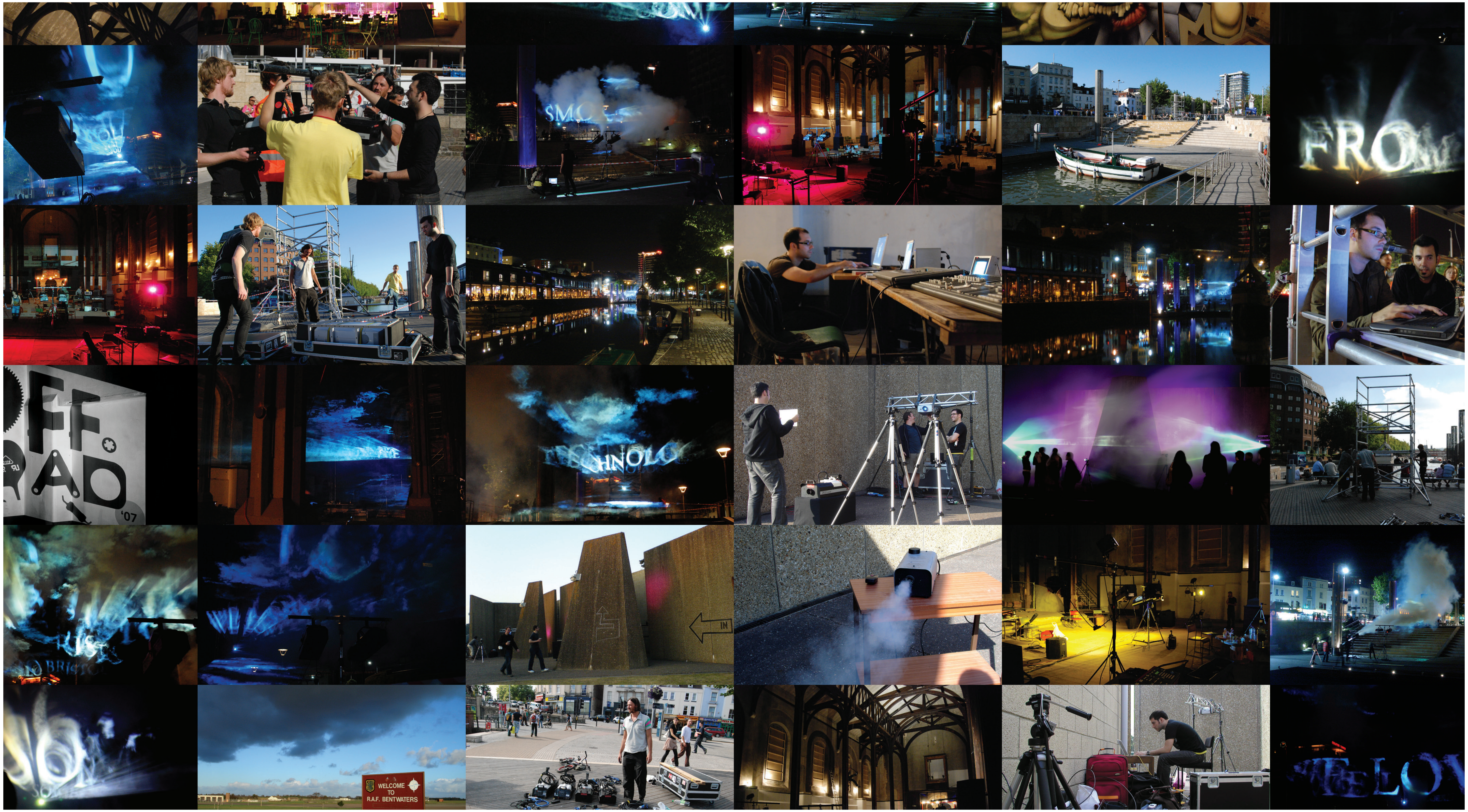


Figure 38: Smoke Signals Development

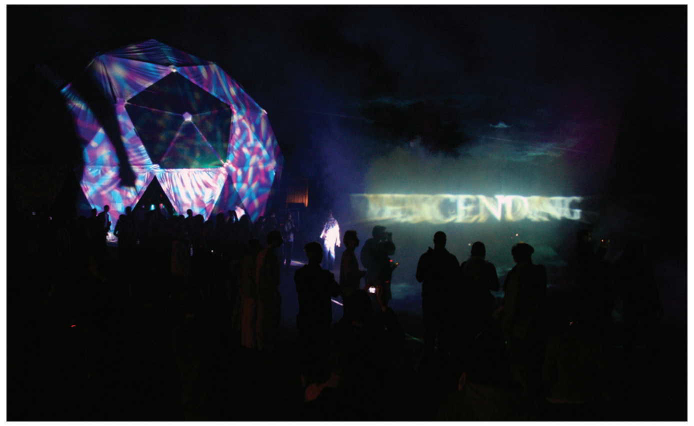
This series of images documents the process, development and installations of Smoke Signals in Suffolk and Bristol, England. These installations posed challenges of various environments and contexts that informed developments that were formalized in the Memory Cloud series.

Figure 39: Audience Participation

In **Memory Cloud** light serves as the principal inscription medium, articulating variability and seamless transformations in the atmosphere in an evolving typographic construction.

This proof of concept in the spatial affect and shared experience was formalised from this early experiment and remained as primary feature in the delivery of the communication in all iterations of the work.

In our second public installation of Smoke Signals which was performed a year later in Bristol, U.K., were we had the opportunity to explore two remote spaces within a short walk from each other; (1) the first outside the Watershed Media Centre in a public plaza in the heart of Bristol downtown harbour, (2) the second inside the Pro Cathedral on Park Place, (a derelict parish Church) that was performed with a sonic component that complemented the environment which was by Steve Reich. Reich's contribution to this was a performance of his Pendulum Music. The duration of the events lasted one hour each, with an approximate combined audience of fifteen hundred. In this experiment we thought to address the issues of intimacy by having two environments that could communicate with each other but have distinct spatial environments that could be experienced and shared with their immediate audiences. This allowed for more intimate exchanges that were immersive and sensorial. This afforded more sustained engagement and this created moments of conversation animating the space through dialogue. The communication between the two sites of the interventions gave two different contexts for participation and this was reflective in the nature of the short form communication participants contributed to the work. This became an important observation that afforded us a deeper understanding on the situational influence and meaning the environment afforded in the behavioural responses of the participants and the conversational enabling that would be a product of this collective engagement.



2006
SMOKE SIGNALS
SUFFOLK, ENGLAND

Duration: 1 hr
Messages:
Local: 200
Remote: 120
Audience: 800
Site: Bentwaters Airbase

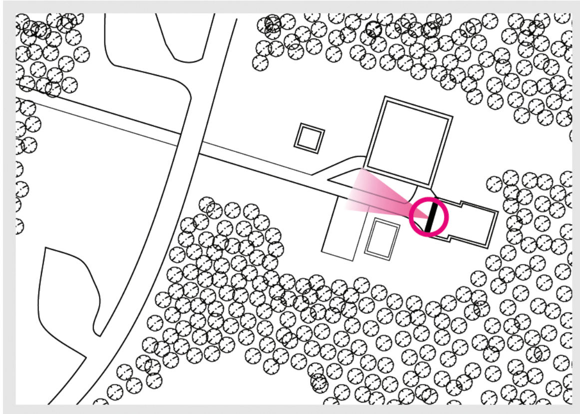
2007
SMOKE SIGNALS
BRISTOL, ENGLAND

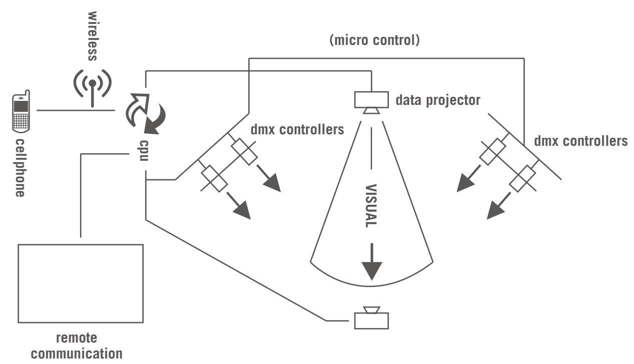
Duration: 2 hrs
Messages:
Local: 532
Remote: 105
Audience: 1,500
Site 1: Bristol Harbour
Watershed Media Centre
Site 2: Park Place Cathedral

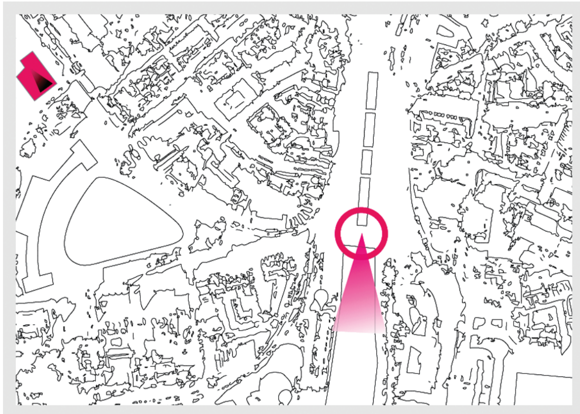
2008
MEMORY CLOUD
LONDON, ENGLAND

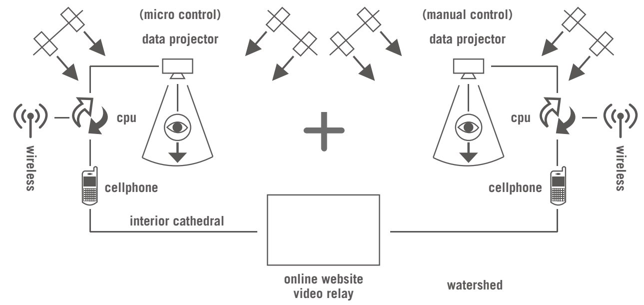
Duration: 7.5 hrs
Messages:
Day 1: 391
Day 2: 525
Day 3: 625
Audience: 7,500
Site: Trafalgar Square

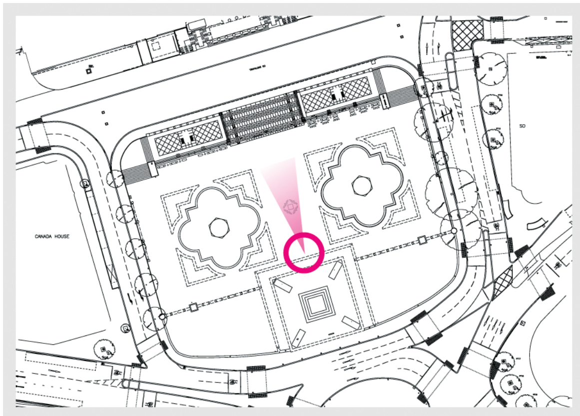
HUMAN HUMAN

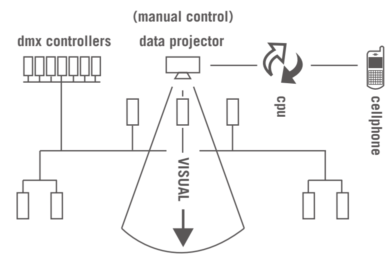












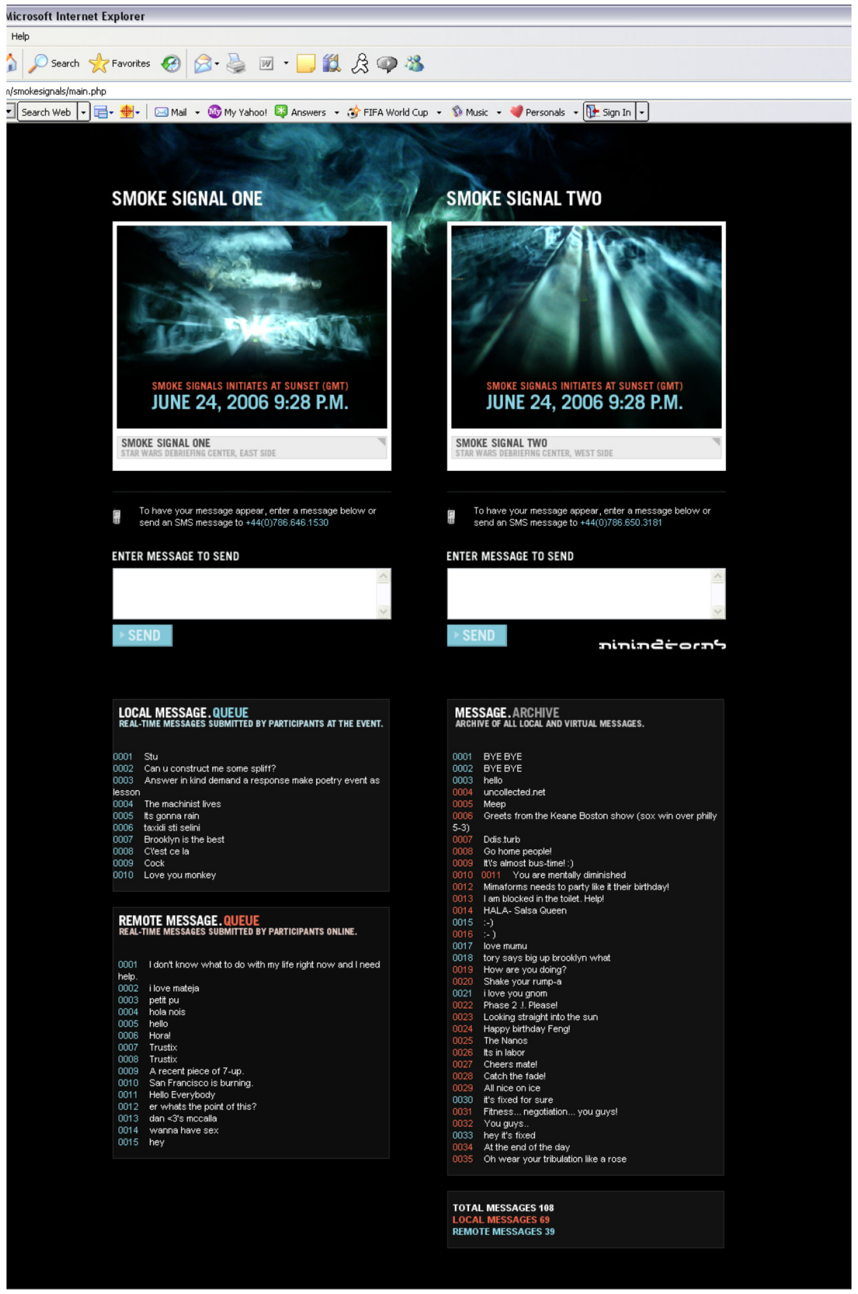


Figure 40: Smoke Signals Communication Framework 1.0

The communication interface of the first installation of Smoke Signals depicted above experimented with immediate and remote communication through an online live feed and text entry.

COMMUNICATION FRAMEWORK

The communication interface of *Memory Cloud* was developed building on the experiments conducted in the two prior *Smoke Signals* attempts. In redesigning the communication interface attempts were made to make as accessible and intuitive as possible. All online data entries and all third party terminal features where stripped out of the communication strategy and the focus became exploiting SMS texts of participants who could communicate and engage at any moment in an intuitive and accessible manner solely through their personal phones. This decision streamlined individual contributions and scaled the potential contributors to the work. To accommodate large groups of participants we developed a system that dynamically received and archived the texts in what could be described in similar way to printing queue. Every contribution was entered at the moment that it was received and published dynamically in an evolving text that was co-authored through the collective at the event. The immediacy and intimacy of the crowd created social scenarios that were experienced in mass in a poetic and transformative way. This was most evident in the last two installations that were developed for the Trafalgar Square (2008)[27] in London and at the DIA (2010) in Detroit Michigan. For the purposes of illustrating some of the developments of the communication framework, the Trafalgar Square installation would communicate the fundamental considerations due to

27 Memory Cloud was critically acclaimed as one of the top ten international public art projects created in 2008 by Damien Noonan in his November 10th article in the Telegraph. Other artists include Olafur Eliasson (New York City Waterfalls), Banksy (The Tunnel) and Richard Wilson (Turning the Place Over).

OVER 1,500 MESSAGES
205 MESSAGES / HOUR
3 EVENINGS

Come home soon dad. Luv Anaya.
Happy birthday jim
PEADAR
i love the spyropoulos brothers
Eat more vegetables
WJ
Hello london
Don't worry be happy
Isn't it playful!
I love Laura.
Bu bu i love you lots your the best thing to have ever happened to me xxxxxx
Loz and lozzle were here yo
I love you shannon x x x
Act for darfur now
Great cha
RETURN OF THE ECHO CHAMBER
Orange Social
Kiss me nelson
Hello Emily
Sacred Grounds
Amy loves Malcolm
I love cute monkeys!
HABIT
Hello Lindsay! xx
nice knowing you dad...
Toby, grow back your goatee, it was cool!
seungyeanlove
Quinn, I like you. S.
NoJason
Don't think of an animal.
Buzz. Purrr. Are you there Sruli?
we love minimaforms
Stephen is my hero!
we love you all
will you marry me
Be the trouble you want to see in the world
we love clouds
damn sexy
Hi smidge x
Smoke&light
The independent republic of the basement is here...
labia
Mcdonalds, Mcdonalds, kentucky fried chicken and a pastahut
Dinosaurs are cool
Will you marry me?
Pazuzu! Pazuzu! Help us pazuzu!
HABIT
B
vulva
theo, when can I get my bucky paper back?
Lubim Ta Kate!

Welcome cK :)
Londonist
Shake it like a polaroid picture
Sandeep Tara we love you
Freya loves old men
Racobito!
Damn fine art
El panochas
buttloads
In my thoughts love
MANGAL CITY
Digit
hugo
everybody happy now
Bam!
Hotel California
Credit crunch over!
What do you think now
Love my jacob!
where's david blaine?
Baby
Save iceland
Quinn, I like you. Shan
2005
Stop sending me text!
trafalgar square
Meet me by the fountain
Shampoo
beautiful work of art
becky loves you
tell me something i dont know
T square after 3 shout "hello toby"...1...2...3...HELLO TOBY!
hot as balls
Buzz
buzzzzzz you
I LOVE YOU MONKEY
i love turtles
? Your mather is mine!
Damien is sexy
Gone with the wind
who loves you more
Sandeep Tara we love you
? Peppino go and get a job!
I want to plug you
My dreams have gone up in smoke
how is everyone doing
Butterfly
Heart bubbles for Minimaforms
where did my friend go
will anyone go on a date with me
Shampoo
:)

Why don't you talk to me memory cloud
this is drl
lotto saturday is 03 07 11 19 25 35 36
;)
what's everyone doing after
party at vals place
hysia
Is ja witzig!
Repeat the action
Alfitude
Blue trafalgar
Mayhem in london
Oh well
Where are the dancing girls?
you are beautiful
where my girls at
tell something about yourself
has anyone seen vanessa
i am a smoke sex machine
the ica rules the school
5 4 3 2 1
you guys are the sexiest people i have ever seen
london the city of dreams
i am a prototype
peace love and everything else
Con mucho gusto !
Salam
I miss Phil
Come home soon dad. Luv Anaya.
be nice to others and they will be nice to you
Allez paris
Alfie is hot stuff
will anyone go out with me
i remember when this awesome thing happend
Muy bonito!
aleks and sara rule the world boo ya
sending love from spain
Tashinopitta
we love you mom
repeat the action
I am the one
ica ica ica ica
Hallo Indonesia!
cooooookies
Like u for everything!!
suger monkeys are sweet
sara hearts aleks!
we loooove you all
love sex machine
rule the school
this is high art
this makes me feel sexy

DAY 1 391 MESSAGES
DAY 2 525 MESSAGES
DAY 3 625 MESSAGES

Fssw rules
Buy low, sell high
Hello London! Its Wicked!
its chilly out but your hoot
Aleks hearts sara
Happy birthday simon. Love ju x
looooooooooove
hello eleni how are you doing
mama spyropoulos is cool
I like to quote films
Hello to all!
Ju you are my world xxx
Windy innit?
Quitterie
Greg Maisie Jabu Jim Christina
Mayday Mayday! I'm hungry!
Becky loves brian
Beer in the CHANDOS anyone ?
who want to party
Sexy blond seeking italian stallion meet me by the fountain
life is like a box of chocolates you never know what your gonna get
Hi From Heavy
Hi From Heavy - Jed
I love u in the morning, i love u in the afternoon, i love u in the evening and underneath the full moon ..Skinny mer ink e do i love u x
Mind the gap
drinks anyone
Christina jim Jabu greg Maisie are all well sexy and cool
Stemma
drinks anyone
Christina jim Jabu greg Maisie are all well sexy and cool
Stemma Happy Eid Everyone!
May the force be with you!
No smoke without fire
Who are you smoke man?
I miss you
Poop
Dahling just not a problem
Leia and Adam love Stavraki
OH YEAAAH!!!!
HEAVY love from PrOdUcErS
Quitterie
where are my friends
Forza inter !
When I grow up I wanna have boobies...
Duuuuuuuuuuuuuuude
I kissed my boss and i liked it
Skinny merink edo i love u x
Skinamerink baby puppy
Christina jim Jabu greg Maisie are all well sexy and cool

steve 4 emma
Pwned by HEAVY
Cher would
Love,and,best's wishes,too Evelin Pold,John CooperX
i
Saffron walden is dope. X x
Luke
beautiful night
jiinyi is super cool
I am legend.
Stemma x
Oh my god, i love josh!
mammal-clan
eleni!!!!!
Mind the gap!
Sexy mermaid
sloth
love
chunk
Becky loves brian
Cats eyes
make love tonight
njabulo esubias is cool
Refuse to dance refuse to dance
anyone know any poetry
FRIDA ZETA
shit, that was supposed to all be one text
say NO to name badges!
Catseyes
Nice seeing you klaus
Greeting's and best wishes,too Emelia Maggio! John cooperX
Io ti amo assai...
KIA ORA FRM NZ
Je-t-aime
Hello little lea. Have some beautiful dreams. See you on friday. love. Your Daddy.
I LOVE FRIDA ZETA
"I don't dance" "I know you can!"
Luke
Stinky stinks
Listen to Minor Threat
cake and sodomy
Lol rofl
Christina jim Jabu greg Maisie are all well sexy and cool
Can you see it klaus!
Emma needs a job.
Spurs are rubbish. Be told
Emma Vickay becky
Love, peace and harmony?
Hello Myah
Kittie! :-D
Bill, all is forgiven.

Bust!
Good times
I am the guy with the weird hat and coat
UVA ROCKS!
BLIGION CLUNGE
I need hugs !!!
Is anybody feelin me?
Robert is great :-)
Where have all the pigeons gone?
mom what do you think
ekaty we love you
Io ti amo assai...
jiiiiiiinyi
Kittie! :-D
It's me, and me. Just me against the music. Uh-huh!
Ostrich
beautiful typography
space future cool
You are awesome
Fatcat 2
UP THE SPURS
Goodnight!
SQUISH!
Allo nelson!
Fantastico
kylestevenson
PERSEPHONE AND BAILS LOVE CLUNGE
I love you totori
Look @ the person next 2 u ... You never know what it might lead 2
I am the credit crunch!
HANNAH
Big fat cat indulgence!
No smoke without firf
Play up pompey!
Saffron walden is dope. X x
kylestevenson
Happy birthday for Maria and Gilbert from Edyta
Kiss me Gareth x
Hola MARCO
Read some Kerouac.
Xx Lula loves Jacobs xX
Love you Lover X X
eleni how are you doing
jinyi how are we looking
anthropophagous giants will get you in your sleep
HolaMARCO
Tricky Ito
tell me everything
Ally & Rachel r the best
yung and emma rock
london

Figure 41: Collective Act of Writing Space

Memory Cloud is a social experiment. The project exists through contributions that served as short form expressions submitted by the general public. The level of interest in others participants messages and collective occupation of a under utilized public space made strong statement of the power of physical space to act as an interface.

Figure 42: Trafalgar Square as Conversational Stage

Fusing primeval and contemporary forms of communication, **Memory Cloud** created a hybrid space that projected personal statements as part of an evolving text, animating the built environment through conversation.

the public nature of the site and social and political climate of the period. *Memory Cloud* in its atmospheric delivery along with its communication interface was developed as a responsive and open framework for public engagement. One of the pressing challenges was the concern of how the general public would behave. The concern from the Greater London Authority extended everyday human scenarios to larger scale crowd behaviours as the asked how would we deal with potential riots and uprising. How would the anticipated large public crowds behave? What would they say? Publications leading up to the event such as *The Telegraph* called *Memory Cloud* "potentially one of the most dramatic – and also most obscene – art events ever to be held in London." The period was a sensitive one due to religious intolerance and other mediated social issues that were of concern. The challenge was to accommodate all concerns, safe guarding the public (and ourselves) without censoring or compromising the integrity of the work. The work in its purest form was pure information communicated through atmosphere. The project initiated and terminated through participation. The system that we developed would allow all communication to be observed before published but would not be removed unless explicitly authorised by the GLA. In preparing for the event all considerations that could be conceived where considered and implemented in a console to allow all parties to understand the project and its implications and through scenario feel comfortable with protocol necessitated to address any circumstances. Through all the build up to the event the interface itself was rarely used[28] as the crowd of participants took the opportunity to speak to each and use the public space of Trafalgar Square that has always been a space of protest and celebration to communicate with each other. To the Institute of Contemporary Arts surprise eight wedding proposals were made over the three days of the installation. To our knowledge 7 of those proposals were successful.

28 A message against the then mayor was not published due to the mayoral elections that were under way.

Figure 43: Constructing Atmosphere

Creating an atmosphere that grafted statements on this ephemeral and transformative formation expressed the environmental writing and erasing of contributions. Through light and fog the space was fully immersive and had not physical limits that limited participants.

Figure 44: Spatial Typography

The constructed space was defined through spatial typography that created different registrations of reference relative to your position within the atmosphere. The latent and uncertain transformations of the clouds created an animated space of communication and experience.

Figure 45: BBC Weather

Memory Cloud's success and overwhelming interest in the work was in large part to the direct accessibility to the work through communication. This simple and powerful idea resonated with the public and press even before anyone had experienced the intervention in Trafalgar Square. BBC weather as an example interviewed us as part of the opening days weather broadcast.

Figure 46: Space as Interface

Animating the built environment through conversation was the primary conceptual driver in this project. In considering an architectural response to space making Memory Cloud problematizes participation and the built through dynamic and shared framework that uses physical space as an interface.

Memory Cloud October 8, 2008 (sample messages):

Come home soon dad. Luv Anaya / Hello London / isn't it playful! / Kiss me Nelson / Toby, grow back your goatee, it was cool! / Be the trouble you want to see in the world / theo, when can I get my bucky paper back? / T square after 3 shout "hello toby"…1…2…3…HELLO TOBY! / Lotto Saturday is 03 07 11 19 25 35 36 / Hello London! It's wicked! / I am the guy with the weird hat and coat / UVA Rocks! / Look @ the person next 2 u… you never know what it might lead 2 / the square looks so beautiful…

Memory Cloud October 9, 2008 (sample messages):

I LOVE YOU, I WILL LOVE YOU MY ENTIRE LIFE, I KNOW IT. HAPPY BIRTHDAY EDU / Hi Ludo, wish you are here! Love Gormiti / Ben is beautiful / Ke you are beautiful / Norma Hibbert walked 87 km London to Brighton but why did media not publicize the great feat? / Geia Sou Ellada / No more Greed / Don't forget to give Minimaforms high fives as the show / Learn how to spell / This moment is for you when the moment has gone will you remember me? / Happy Emmaversary! Emma Humphrey / Bread + Fire = Toast / Is your name Elisa? / Girl in brown leather jacket is hot / we only have ghost memories feeling dreams / do u seek stability and recognition the way these letters do? Claire Stewart will you marry me?

PROTOTYPING

Over six years Memory Cloud went through a series of developments and incremental advancements. With respect to other projects featured within this thesis Memory Cloud did not have visible developments but rather worked towards stripping away elements like discussed in the communication framework that complicated or distracted from the experience and interaction of the participant. Each site due to the environmental factors where unique as the variability and weather on any giving night could only be addressed through a design strategy that by necessity needed to be adaptive to allow for latent and uncertain circumstances to be addressed. From an atmospheric aspect hundreds of iteration of material dissipation rates and optical studies where done to understand the material behaviour and affect that was produced through light and fog. This intuition through working with the material phase change processes allowed us to understand the nuances of this process. Control in this context was an illusion. The environmental variables continually reshape the projected messages through the dynamic writing and erasing of messages. This constructed atmosphere allowed the text to transform in scales and incarnations along the driftscape of projected light. Accelerating airflow increased rates of dissipation further by transforming the volume and density of the space of projection. The observers' spatial perception continually pursued dynamic stability through forms of legibility in motion perception. From an interface perspective the developments went mainly on making the system robust and accessible to the general public.

Figure 47: Faster Than Sound Festival, 2006

Our first installation of Smoke Signals took place in Suffolk, England. The site had many challenges from power to wifi access that informed the later developments and strategies of deploy ability of the system.

Figure 48: Smoke Signals, Bristol, 2007

Our second installation of Smoke Signals took place in Bristol, England in two sites simultaneously. This intervention included the only experiment that we developed within an existing structure. All other interventions took place in public spaces.

Figure 49: Memory Cloud, Trafalgar Square, 2008

Our third installation took the name Memory Cloud and was installed in Trafalgar Square, London, England. The project selected the site for its rich history of public communication through celebrations and demonstrations. This public space as interface was to be reanimated through the Memory Cloud.

Figure 50: Memory Cloud, Detroit Institute of Arts, 2010

Our fourth and last installation of Memory Cloud was performed out the Detroit Institute of Arts. The project part public outreach worked with local organizations and institutions in the months leading up to performance.

Figure 51: Faster Than Sound Festival, 2006

First installation of Smoke signals included two projections that converged. Each smoke signal projection was connected to a local and remote feed.

Figure 52: Smoke Signals, Bristol, 2007

Second installation of Smoke Signals experimented with two local environments that communicated between each other. Each of the two sites where within walking distance.

Figure 53: Memory Cloud, Trafalgar Square, 2008

Our Trafalgar Square installation of Memory Cloud for the first time was performed over three nights for two and half hours. The installation was performed was seen by an estimated audience of each night of 35,000 people.

Figure 54: Memory Cloud, Detroit Institute of Arts, 2010

Memory Cloud Detroit was performed over three nights animating the DIA structure through the testimonies of the general public. Two nights of the performance took place when the museum was normally closed.

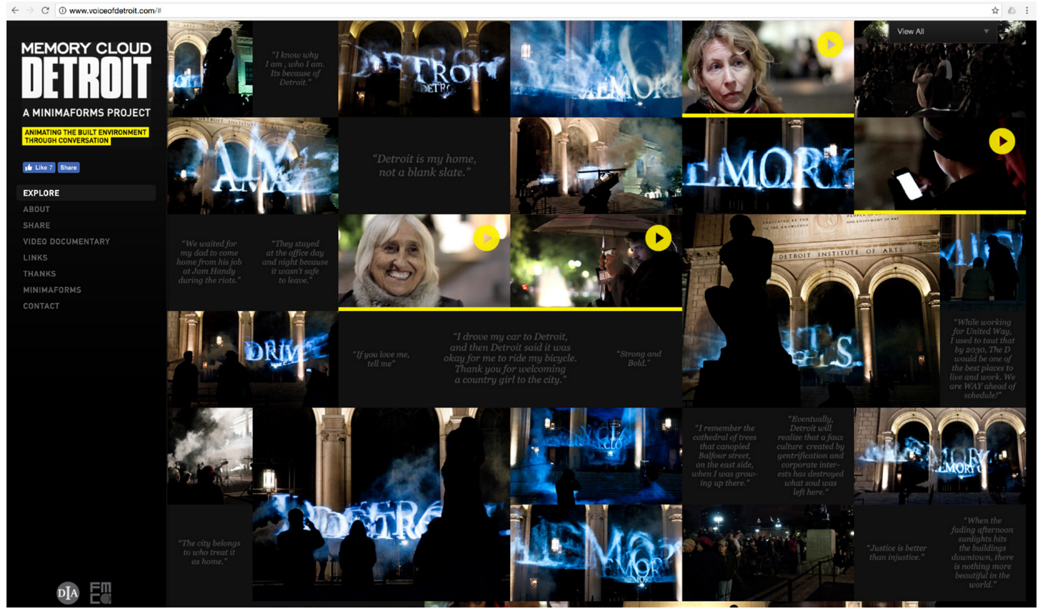


Figure 55: Voice of Detroit Archive

Voice of Detroit is an online archive of all the contributions received during the performance of Memory Cloud.

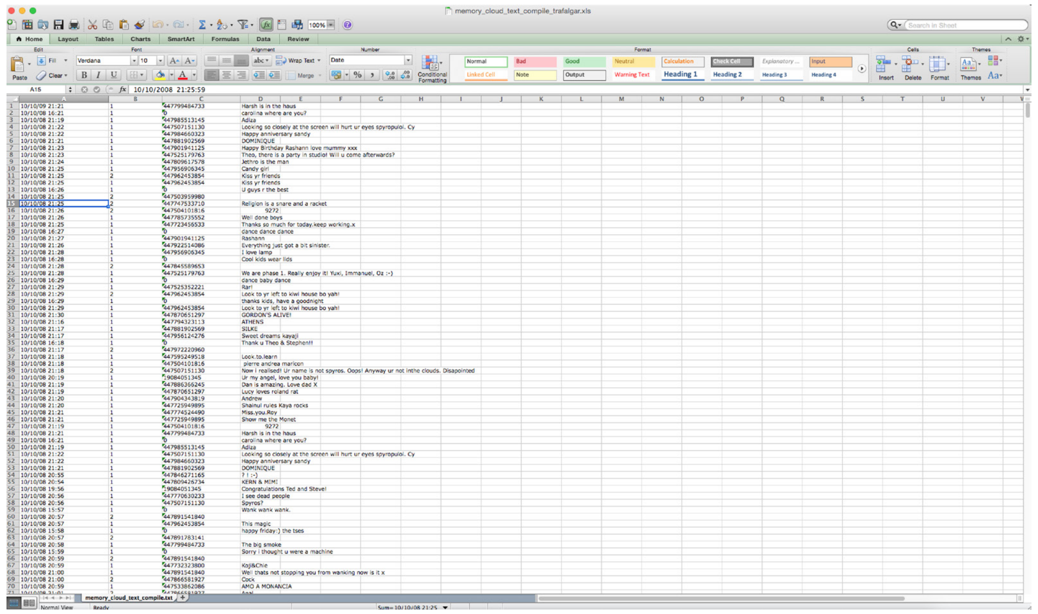


Figure 56: Message Database

Each installation of Memory Cloud included a database system that archived all contributions to the performance. This archive within this thesis served to study the contributions relative to the context and framework of participation.

OBSERVATION

In 1946, Lucio Fontana had declared in *The White Manifesto* that 'we need a change in essence and in form. We need to go beyond painting, sculpture, poetry and music. We need a greater art in harmony with the requirements of the new spirit'. He offered his vision of this new spirit through what he saw as 'the construction of voluminous forms changing through a plastic, mobile substance. Arranged in space they act in synchronic form, they complete dynamic images'. Messages communicated through Memory Cloud are continually reformed as the space of projection is grafted onto atmospheres of shape shifting volumes of fog. In this second research experiment there was a purposeful negation of the machines, hardware and other visible features of the work in an attempt to highlight communication and conversation. In many ways this challenged natural instincts of design iteration and focused most of the development in the observation and attention in human engagement. The main conceptual driver was to animate the built environment through conversation and through this attempt design an intervention that was executed with the most minimal of means. This light touch in the existing contexts offered a great deal of perceptual play as with minor exceptions the project existed as a construct only through personal expressions and conversation that was shared. The project in its durational form existed as long as the conversation and contributions were active. The project like the model of conversation that Pask argued in his conversation theory was contingent to participation and with this observation it is within this thesis the most articulated moment of discovery that has preoccupied this research and what is to follow. The attention to information and the role of atmosphere was a correlation that was at the heart of the juxtaposition of one of the oldest forms of communication Smoke Signals with contemporary SMS texting. This five thousand year slice of communication lineage challenged the fixity of architecture and brought about a means to consider architecture as atmosphere, what in this thesis I call environment. Director of FRAC Centre in Orleans, France Marie-Ange Brayer describes in her article *Minimaforms: Architectural Disseminations into the Atmosphere*, how the concept of atmosphere and information in Memory Cloud offers new insight on the challenges of the digital revolution. She states, that "Today, the concept of atmosphere includes a physically controlled environment or an 'informational territory' (Andrea Branzi). If architectural projects tend to disintegrate into electromagnetic fields or in the physicality of climates, they echo an attempt to articulate the physical and the cognitive, to deterritorialise the project, to give it an emergent, processual dimension. Minimaforms' Memory Cloud (2008) precisely breathes an atmospheric dimension into architecture while endowing it with shifting anthropic contours. It makes use of the entropic aspect of the atmosphere, which enhances the sensorial and cognitive experience. The installation is a constantly crystallising and dissolving cloud of information. Information becomes energy, which in turn becomes information again. Memory Cloud is a kind of living, pulsating organism. The atmosphere allows for a form of transitory inhabitability. In Memory Cloud, the layers of memory are atomised and transformed into material energies. This transformational dimension opens up a new collective, indeterminate space in constant re-creation. By taking into account the passage from utopia to atopia, Memory Cloud abandons space in its Kantian form and enables another form of subjective reappropriation to

emerge."[29] This concept of communication embedded in material form that is transient exhibited meaning to many participants. The poetic and transformative delivery was most acutely exhibited in the contributions that were submitted in the last intervention that was installed outside the Detroit Institute of Arts in downtown Detroit.

Sample messages from Memory Cloud, DIA / Detroit, 2010.

> "I know why I am, who I am. It's because of Detroit"
>
> "Detroit is my home, not a blank slate."
>
> "Rest in Peace My Beautiful, sweet Jessica Andre"
> "This town is sleeping for 100 years can you wake them up in you memory clouds of hope?"
>
> "Please help all the abandoned souls who are looking for a Memory Cloud to float on."
>
> "I live in an alley in the Cass Corridor. It took me 15 years to find a job in Michigan. For the first time in 15 years, I don't want to be elsewhere."
>
> "Good girls go to Paris and bad girls go to Detroit."
>
> "Eventually Detroit will realize that a faux culture created by gentrification and corporate interests has destroyed what soul was left here."

29 Spyropoulos, S. and Spyropoulos, T. (2010) Enabling: The Work of Minimaforms. London: Architectural Association Publications.

Figure 57: Memory Cloud Detroit, 2010

Memory Cloud Detroit remains the most influential intervention within this thesis highlight and demonstrating the power to influence in a positive manner. Following our performance the city of Detroit and the local art organizations develop a light biennale inspired by Memory Cloud that would use the city as a canvass for communication.

"While working for United Way, I used to taut that by 2030, The D would be one of the best places to live and work. We are WAY ahead of schedule!"

" I was born here and will gladly die here under the crackling echoes of this electric light."

"Corrupt"

"My people are buried here, so I stayed."

"Detroit is in my heart and soul and on my mind – We have a love / hate relationship."

"I used to love Detroit – but then they burned my house down – now I am sad because it exists no more."

"The Thanksgiving Day Parade is a memory that will never fade. I attended from 1955-1962. Best Parade in the world."

"The D is basically a shithole, but I luv it anywhos."

"MEMORY CLOUD is the DEMENTIA of DETROIT."

"Honk your horns, because this is the motor city."

"My grandfather took me downtown after the 68 riots. We stood at the top of Washington Blvd, it was the only time I saw him cry."

"15th, April I met Mr. Lee. I will remember that day ever and forever."

"My father tells me those big steam clouds rising from the sewers is the Devil rising from Hell coming for bad kids. It totally made sense to me."

Over the three days in London or Detroit, the project teased out playful interactions and experiences. Memory Cloud offered participants the ability to lose themselves through the evolving relationships with the piece and each other. Their messages shaped the space of interaction and offered stimulus for further exchange. Fittingly enough, the last message broadcast by Memory Cloud in Trafalgar Square animated the space with the words, 'Gordon's Alive'.

Through this conversational form of interaction, public spaces such as Trafalgar Square in London and the DIA in Detroit transformed into a dynamic stages of communication. The shared and collective nature of the communication constructed an evolving and complex set of relationships, which enabled sustained novelty and crowd based co-operative interaction. *Memory Cloud Detroit* demonstrated the power of this model of interaction to enact change through its ability to bring communities together and use the city as a medium of communication. The impact of this ephemeral work that was performed over three days resonated with the community that it served as the basis of a city initiative in the form of a light biennale named DLECTRICITY that continues till today to explore the city as canvas for collective expression.

HUMAN MACHINE

"I shall consider the physical environment as an evolving organism as opposed to a designed artefact. In particular, I shall consider an evolution aided by a specific class of machines. Warren McCulloch (1956) calls them ethical robots; in the context of architecture I shall call them architecture machines."

Nicholas Negroponte, The Architecture Machine (1970)[1]

Human Machine frameworks examine the evolving dialogue between human and non-human agents interacting within an environment. The emphasis in this chapter looks to extend the conversational coupling between humans and machines. Initial research experiments featured in the first chapter *Human Human* focused on the development of design systems that enabled human participation through personal contributions that were shared and collective in nature. The system stimulated human responses, which triggered conversational exchanges between participants that further feed back into the theatrical framework. In evolving the experiment the authored works featured in this chapter give agency to the systems themselves. The pursuit has been to explore the capacity to develop frameworks that foster intuitive interaction and curiosity, exhibit life-like characteristics and enable emotive responses. The subject of behaviour features as the critical apparatus within these explorations as it affords

1 Negroponte, N. (1973) The Architecture Machine: Toward a More Human Environment. Cambridge, Mass: The MIT Press.

Figure 58: French Science Magazine Science et Vie, September 1956

Nicolas Schöffer and Philips designed and developed what is considered the first cybernetic sculpture titled CYSP-1 in 1956. The name CYSP-1 was derived through the fusion of the words cybernetics and spatiodynamic into a new concept for a robotic dancer. Through illumination, kinetics and sound this theatrical performer featured in theatre and dance performances of the time.

the capacity of non-human agents to communicate with human agents and vice versa. Communication through behavioural response necessitates an internal self-awareness and outward expression. Through gesture, kinetics, illumination and aural communication the opportunity to construct interaction scenarios through the design of things that engage human interaction will be examined.

Interaction between human and non-human agents is understood as continuing an evolving discourse through cybernetic and behaviourist frameworks. In the mid to late sixties a series of provocative articles and experiments primarily by British protagonists attempted to argue for a new conceptual paradigm that examined the interrelationship of cybernetics, art, architecture and engineering. Telematic artist and educator Roy Ascott, believed that contemporary art (what he called modern art at the time) had to move beyond obsolesce of literal forms of definition and understanding. He proposed a new framework for art that moved towards relational and systemic pursuits that he identified this through a cybernetic and behaviourist position. He stated this in his seminal article written in 1964 titled *The Construction of Change*; “Cybernetic method may be characterized by a tendency to exteriorise its concepts in some solid form; to produce models in hardware of the natural or artificial system it is discussing. It is concerned with what things do and how they do them, and with the process within which they behave. It takes a dynamic view of life, not unlike that of the artist. Phenomena are studied in so far as they do something or are part of something that is being done. The identity we give to what we perceive is always relative, yet it presupposes a whole. Everything changes ceaselessly; we investigate our world best by seeing the system or process before evaluating the ‘thing.’ Cybernetics is concerned with the behaviour of the environment, its regulation and the structure that reveals the organization of its parts.... Cybernetics is not only changing our world, it is presenting us with qualities of

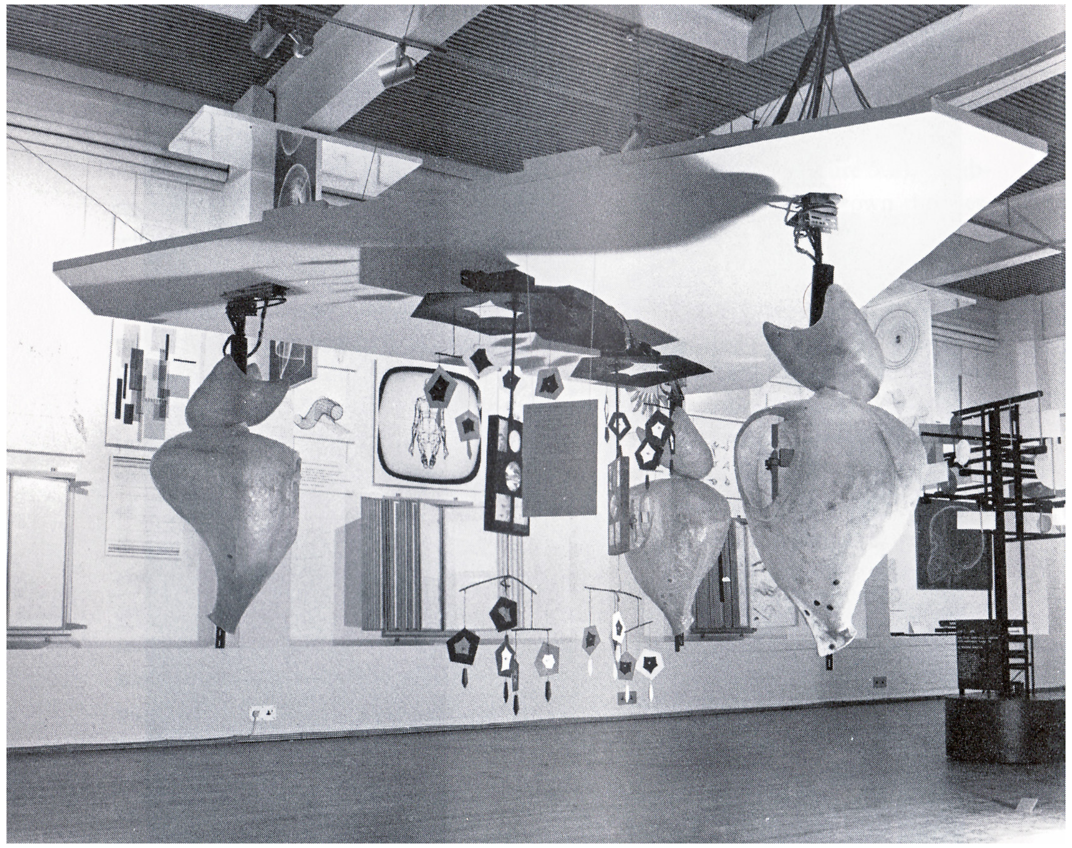


Figure 59: Gordon Pask, The Colloquy of Mobiles, ICA London 1968

One of the first Human Machine constructs that was developed by Pask for Jasia Reichardt's Cybernetic Serendipity, ICA London, 1968. The Colloquy of Mobiles developed a mobile-to-mobile communication strategy that humans could participate in. Petting Zoo developed by the author develops this approach to interaction.

experience and modes of perception that radically alter our conception of it."[2] As Ascott attempted to consider a behavioural position for art, cybernetician Gordon Pask expressed a similar sentiment in his definition of what constituted an aesthetically potent environment. Pask articulated his concept in his seminal paper *A Comment, a Case History and a Plan*, by explaining four key attributes that satisfy implicitly this condition:

A It must offer sufficient variety to provide the potentially controllable novelty required by a man (however, it must not swamp him with variety—if it did, the environment would merely be unintelligible).

B It must contain forms that a man can interpret or learn to interpret at various levels of abstraction.

C It must provide cues or tacitly stated instructions to guide the learning and abstractive process.

D It may, in addition, respond to a man, engage him in conversation and adapt its characteristics to the prevailing mode of discourse. [3]

Condition d introduces conversation as a subject of Pask's preoccupation that in the context of this thesis unfolds an open-ended interplay of relations between humans, machines and environments. Architecture in this thesis is understood as an environment. Pask in his paper[4] illustrated his concepts of an aesthetically potent environment through two prototypes (*Musicolour* and

2 Ascott, R. (2008) Telematic Embrace: Visionary Theories of Art, Technology, and Consciousness. 1 edition. Berkeley: University of California Press, p 100.

3 Pask, Gordon, 'A Comment, a Case History and a Plan', in J Reichardt, Rapp and Carroll (eds), Cybernetic Serendipity, 1970, reprinted in J Reichardt (ed), Cybernetic Art and Ideas (London: Studio Vista, 1971), p 76.

4 It is relevant to note that Pask's article *A Comment, a Case History and a Plan* was written prior to Jasia Reichardt's ICA exhibition *Cybernetic Serendipity* which featured Pask's *Colloquy of Mobiles*.

Colloquy of Mobiles[5]) that demonstrated his approach to an open framework that would promote performative interaction. In discussing *Colloquy of Mobiles*, Pask argued for a framework that is human responsive not human contingent. This is an important distinction in the experiments that are featured in this chapter in contrast to the experiments that have been discussed in the Human Human chapter previously. Unlike in *Facebreeder* or *Memory Cloud* where the machine becomes a communication vessel that necessitates human contributions to create an environment for human observation, the attempt in this chapter is to explore agency and a co-dependent framework that allows the system (machine) to interact with other machines as well as with human participants. This ability affords the system agency and can stimulate more complex scenarios to unfold over time. Pask explained in his conception of *Colloquy of Mobiles*, it "is socially orientated, reactive and adaptive environment. Even in the absence of a human being, entities in the environment communicate with and learn about one another. But a human being can enter the environment and participate; possibly modifying the mode of communication as a result."[6] Prototyping within this thesis plays a critical role in operationalizing cybernetic concepts and creating a context that allows for design methods to explore behaviour.

Through making these machines and systems there has been an attempt to communicate in method and practice the cybernetic qualities and understanding that can be exhibited through a behavioural framework for design. The thesis attempts to expose the cybernetic nature of design as an activity through conceptualising, constructing, observing and correlating human exchanges with their behavioural response. This feedback loop of design, prototype, test, observe

5 *Colloquy of Mobiles* was conceived as a response to Jasia Reichardt's invitation to exhibit in her 1968 show titled Cybernetic Serendipity held at the ICA in London.

6 Pask, G. (1971) 'A Comment, A Case History and a Plan', in Noll, M., Moles, A. A., and et al., Reichardt, J. (ed.) Cybernetics, Art, and Ideas. First edition. Greenwich, Conn.: New York Graphic Society, pp. 88.

and redesign in the process of creating a work is conversational. This cybernetic design and scenario based process is clearly articulated by architect and educator Stephen Gage when he states "This process involves placing hypothetical objects (designs) in a hypothetical world — a construction that describes aspects of the physical world – to see whether the design "works". There is often a driving need to know." [7] The desire to know is complex and with respect to the work argued for in this pursuit of architecture uncertain. The nature of an open framework argued for within this behavioural design method is at various stages elusive, latent and unknown. This design search extends beyond research and is in the work presented here part of the conceptual strategy to allow for the system itself to be curious and adaptive in its implementation. To make these affordances the system itself necessitates it own agency and behavioural attributes. The pursuit is in co-evolving relationships between systems of interaction. This co-dependency is performative in nature and highlighted in Gage's interest in the physicality of design constructs as performers within an environment. Gage offers an alternative approach to Pask's *Entailment Meshes* that articulates observer dependencies by suggesting that performative systems could "enjoy the prospect of ambiguity – creating a construct that can be reconstructed in different ways at different time by other observers."[8] Gage in this instance uses a Glanvillian concept of "ambiguity" being a systemic driver for time-based variety. Gage highlights distinctions in Paskian pursuits of "complexity" and Glanvillian "ambiguity" though reconciles these distinctions through pursuit of novelty and observer construction as a performance. The status of these constructs oscillates in-between and the richness may lay in the capacity for them to be realised through an observer(s) over time. The observer(s) and performer(s) in this context are defined by their behaviour rather than a prescriptive definition of actors within a systemic exchange. Humans, machines, environments construct an evolving time based

7 Gage, S; (2007) How to design a black and white box. Kybernetes , 36 (9-10) pg. 1332.

8 Gage, S; (2007) How to design a black and white box. Kybernetes , 36 (9-10) pg. 1333.

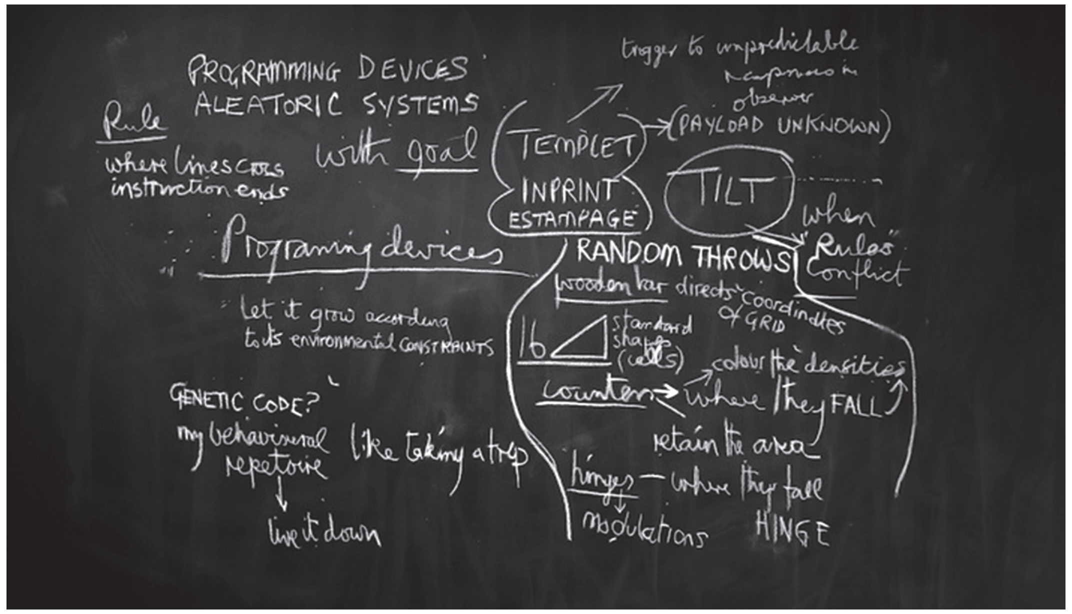


Figure 60: Roy Ascott Blackboard Notes 1966

Ascott's cybernetic approach to art and education developed through conceptualising behaviour. His early cybernetics work evolved into telematics and the development of innovative learning environments.

Figure 61: Rafael Lozano-Hemmer, Amodal Suspension, (YCAM), Japan 2003

Amodal Suspension is part of Lozano-Hemmer's Relational Architecture series of large-scale interface experiments that script light sequences through cell phone communication registered as light.

and situational dynamism that allows variety and novelty to emerge through interaction, learning and the pursuit of control. The status of their agency is situational rather than prescribed and this over time allows the system variety in the pursuit of novelty but more fundamentally the opportunity for performers to construct understanding and evolve the discourse that is a product of this understanding.

Sociologist Andrew Pickering in his book *Cybernetic Brain* explains, "cybernetics does suggest a new strategy, a novel way of going on, in the creation of art projects. We could try to construct objects with the foreground. Pask articulates this explicitly in his fourth attribute where he expresses the need to "engage a man in conversation," which "externalize this discourse" as Pask also put it – rather than effacing or concealing the engagement, as conventional art objects do. Cybernetics thus invites (rather than requires) a certain stance or strategy in the world of the arts that conventional aesthetics does not."[9] Experiments developed in this thesis attempt to develop design frameworks that could be understood to exhibit features of what Pask's calls an aesthetically potent environment, suggesting a dynamic and evolving scenario based framework that operates through generative and consequently performative forms of interaction. Prescriptive or predefined agency is challenged as well as commonly held conventions of architectural definition of space and form. These interaction scenarios allow for complex and non-linear exchanges to form. Satisfying Pask's conditions allows for a systemic form of practice to design conditions that allow and foster pleasurable interaction through open and accessible protocols of engagement.

9 Pickering, A. (2011a) 'Gordon Pask: From Chemical Computers to Adaptive Architecture', in *The Cybernetic Brain: Sketches Of Another Future*. Chicago, Ill: University of Chicago Press, pp. 323.

Framework for Now: Writing the Rules Playing the Game

The human / non-human component in this framework allows for novel and complex relationships to emerge through their adaptation, a key feature afforded through active participation. The passive receiver relationships in traditional forms of spatial interfacing are shifted towards active and shared forms of influence. The complexity of human participation and behavioural interfacing challenges the pre-established goal oriented means that typified systemic practice and method. Ascott identifies this creative form of participation as an extension of channels of communication and modalities that establish a feedback loop. The framework for this interactive play he explains takes the form of a game. “This situation, in which the artwork exists in a perpetual state of transition, where the effort to establish a final resolution must come from the observer, may be seen in the context of games. One can say that in the part the artist played to win and so set the conditions that he always dominated the play. The spectator was positioned to lose, in the sense that his moves were predetermined and he could form no strategy of his own. Nowadays, art is moving towards a situation in which the game is never won, but remains perpetually in a state of play. While the general context of the art experience is set by the artist, its evolution in any specific sense is unpredictable and dependent on the total involvement of the spectator.”[10] This context dependant but ruled based approach to play allows the “game” as Ascott mentioned to evolve through shared and legible protocols of engagement. The analogy of a game is an important one as the concept of writing rules that make legible this interaction also allows for the emergent qualities of play to create novel situations through interaction of players within an environment. Players in Ascott’s metaphor can be equated to Pask’s concept of participants.

10 Ascott, R. (2008) Telematic Embrace: Visionary Theories of Art, Technology, and Consciousness. 1 edition. Berkeley: University of California Press.

The game as a framework for the system would evolve through this systemic play, allowing for the rules of the game to unfold a process of becoming affording emergent complexities to give form to further play. The game rather than a fixed set of rules that would constrain would enable and allow for players to shape the terms of how the game itself would be further engaged. This active engagement as influencing machine gave rise to provocative and controversial questions in particular in the context of art. The artist understood in conventional forms of artist practice to construct and communicate a message through his work, now would be confronted with the desires and messages of observers who would influence the framework of communication as a critical feature of the work itself. This confrontation with participants’ desires and influence is at the heart of the authored research experiments that have been conducted in this chapter. Ascott would address this through his belief in the radical nature of a new era of culture that could emerge through the coupling of cybernetics, art and technology, “ the artist is doing little more than explore his new relationship to the spectator, he is searching for new ways of handling ideas, for more flexible and adaptive structures to contain them; he is attempting to generate new carrier-waves for the modulations of contemporary experience; and he is searching the resources of technology to expand his repertoire of skills. His concern is to affirm that dialogue is possible-- that is the content and the message of art now; and that is why, seen from the deterministic point of view, art may seem devoid of content and the artist to have nothing to say. The modern means of communication, of feedback and viable interplay-- these are the content of art. The artist’s message is that extension of creative behaviour into everyday experience is possible.”[11] Through an engagement with the everyday a critical position with respect to conversational and participatory environments is posed by Ascott and Pask,

11 Ascott, R. (2008) Telematic Embrace: Visionary Theories of Art, Technology, and Consciousness. 1 edition. Berkeley: University of California Press.

which has less to do with the interest on what forms the content of conversation but rather how conversations take place. An environment is situational; scenario driven and can exhibit means to observe how people learn with respect to the behavioural framework they are participating in. An environment stimulated through this form of intimate and situational behaviour would not operate through representational forms of assimilation but through performative sensitivity endowed through a real-time response to the "now." This immediacy and real-time communication offers the architecture an opportunity to explore space as the interface of our interactions.

In conceiving of a framework for an immediate and anticipatory architecture of the now, analogous concepts influenced by avant-garde theatre and performances were embraced. Early cybernetic machines such as Gordon Pask's Musicolour and Nicolas Schöffer's Sculptures Spatiodynamiques demonstrate a theatrical interest through performance by staging a platform from which participation experience and ambient effects could be amplified and engaged with. Andrew Pickering describes these experiments as a form of cybernetic theatre and in particular identifies Pask's concepts of second order cybernetics to have a strong theatrical influence. Pickering attributes this to Pask's ability to be, "entirely free to follow his own inclinations in developing his cybernetics in a theatrical direction, a more or less unprecedented development. At the same time, this lack of disciplinary control helps to account for another aspect of the novel form of Pask's cybernetics - his abandonment, already in the early1950s, of the idea that cybernetic systems seek by definition to pursue fixed goals."[12] This abandonment for the fixity of goals as described by Pickering opened a speculative and experimental terrain for which architecture could play an integral role in the

12 Pickering, A. (2011a) 'Gordon Pask: From Chemical Computers to Adaptive Architecture', in The Cybernetic Brain: Sketches Of Another Future. Chicago, Ill: University of Chicago Press, pp. 309–371.

evolution and application of this second order cybernetic thought. Pask stated this in his seminal paper *The Architectural Relevance of Cybernetics*, "Cybernetics is a discipline which bills insofar as the abstract concepts of cybernetics can be interpreted in architectural terms (and, where appropriate, identified with real architectural systems), to form a theory (architectural cybernetics, the cybernetic theory of architecture)."[13] He argued that architects are systems designers and by necessity to address the ever-growing complexity had to conceptualise an operational theory that he believed was cybernetics. He stated that there were no conceptual frameworks, "the new (augmented) architecture had not yet developed one. Another way of putting it is to say there was no theory of the new architecture."[14] This argument for cybernetics and conversation theory accounts for a framework to consider participation, agency and behaviour in adaptive systems as architectural attributes.

There is only one point of contention to Pask's argument in his architectural consideration and it may be meaningful to consider what he terms architectural "functionalism and mutualism". He articulated his concepts of architectural functionalism and mutualism when he stated; "The functions, after all are performed for human beings or human societies. It follows that a building cannot be viewed simply in isolation. It is only meaningful as a human environment. It perpetually interacts with its inhabitants, on the one hand serving them and on the other hand controlling their behaviour. In other words structures make sense as parts of larger systems that include human components and the architect is primarily concerned with these larger systems; they (not just the bricks and mortar part) are what architects design. I shall dub this notion architectural 'mutualism' meaning mutualism between structures and men or societies."

13 Pask, G. (1969) 'The Architectural Relevance of Cybernetics', Architectural Design.

14 Ibid.

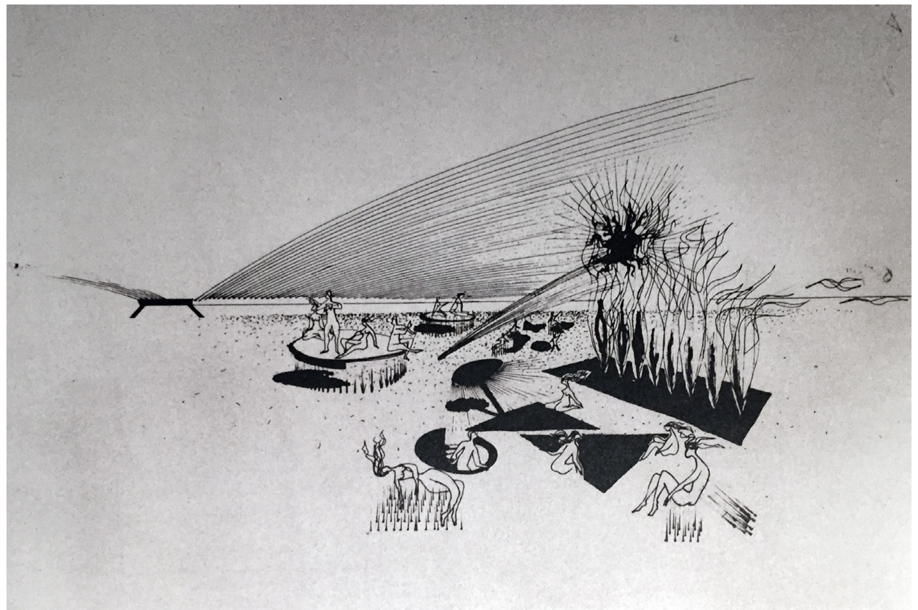


Figure 62: Claude Parent / Yves Klein Air-Conditioned City 1959-1961

Parent and Klein's collaboration explored a vision of the city as atmosphere. Through elemental features the environment was consider an open framework that was theatrical and performative.

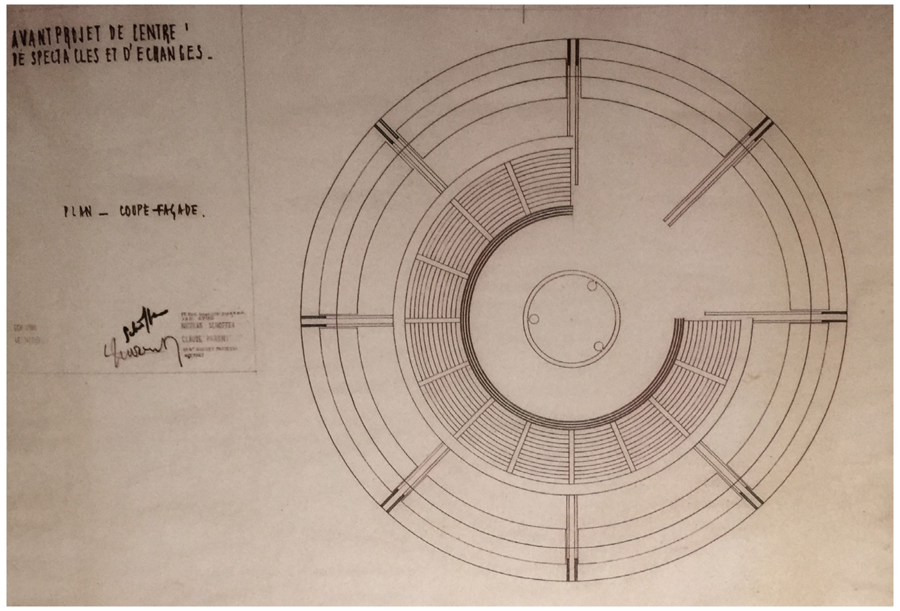


Figure 63: Claude Parent / Nicolas Schöffer Spatiodynamic Centre de Spectacle, 1955-1956

Parent and Schöffer collaborated on speculative architectural scaled spectacle in 1955 that extended the Spatiodynamic concepts of Schöffer into a concept for the city.

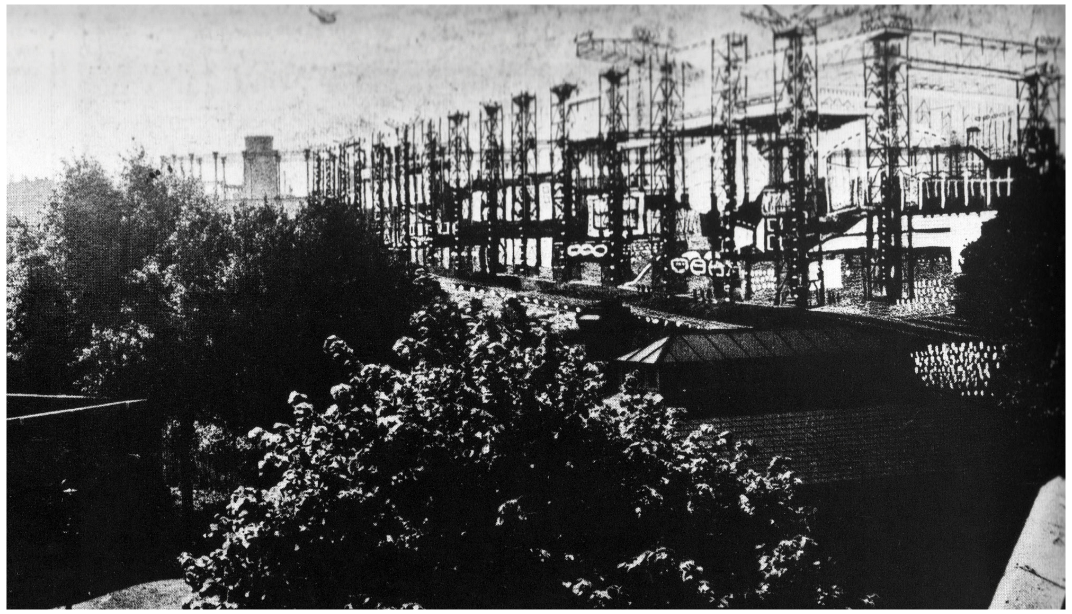


Figure 64: Cedric Price, Fun Palace, London, 1959–1961

A seminal collaboration that was developed between Cedric Price, Joan Littlewood, and Gordon Pask that explored a temporary and mutable structure that would construct an operable framework for the general public to use.

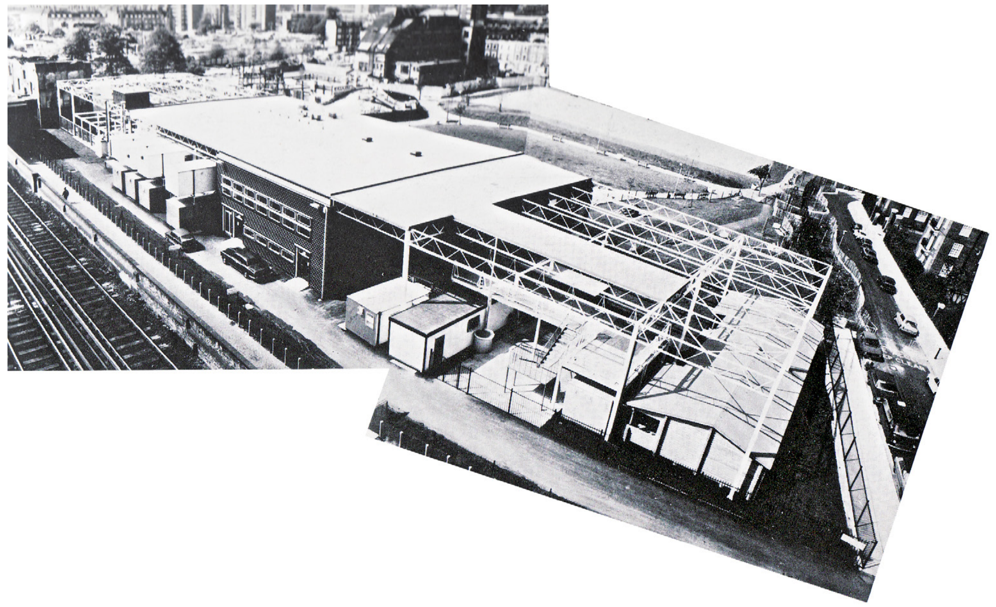


Figure 65: Cedric Price, InterAction Centre, Kentish Town, 1976

The InterAction Centre was a modest building realized in the spirit of the Fun Palace. Though successful in demonstrating aspects of his concepts, Price played a role in its demolishing 2003 as he believed that building should not outlive their intended use.

[15] Though his main argument in his article *The Architectural Relevance of Cybernetics* articulates the need for architecture and cybernetics to be considered in a shared and mutual conceptual and systemic trajectory. His concept of serving and controlling in this specific instance seems antithetical to his prior theoretical writings and his experiments which feature in this thesis. Pask's suggestion that one of the functions of architecture was the capacity for "controlling their behaviour", renders itself deterministic as an objective which does not resonate with the overall approach of how architecture within this thesis is argued for. Rather considering architecture as a participant(s) and or performer(s) that may "influence" I believe is more in line with Paskian concepts of conversation theory that I have attempted to illustrate through his maverick machines.[16] In regards to his concept of "serving" which lends itself to contemporary proto-functionalist approaches of on demand function; the variety and wonder that Pask speaks of in his theatrical performances that are rich and nuanced in concept seem to be limited and hyper-constrained in its systemic articulation with his theoretical openness with respect to architecture. Architecture in this thesis challenges and engages actively residents or visitors recognising that humans remain the most adaptive of all elements within *Human Machine* framework today. Through theatre and performance the concept of "now" lends itself to spatial and time-based considerations that move design speculation within a cybernetic discourse towards architecture. Architecture considered as a spatial medium and interface could allow for an open framework to be prototyped and conceptualised as a construct for the everyday. Pickerings' observation of the "abandonment of fixed goals" in Pask's methodology highlights his desire through Conversation Theory to explore variety and wonder through relational goals that could evolve over time. The dynamic and transformative

15 Ibid.

16 Architecture in Pask's statement is presumed to be holistic. This will be challenged in the concluding chapter that will speculate on the agency of architecture to create space and embody behavioral attributes through high population agent assemblies that embrace eusocial organizational principles.

capacity of this systemic approach offers a new conceptual model for the conception and evolution of architecture.

Evidence of this speculation was formalized in the theatrical conception and design of the seminal collaboration of Cedric Price, Joan Littlewood, and Gordon Pask in the Fun Palace proposal. The Fun Palace itself evolved concepts influenced by German playwright and theatre director Berthold Brecht. Brecht's concepts of modern theatre explored active spatial mediums for social communication through collective and collaborative experimentation. Stanley Matthews discusses the influence of Brecht on the avant-garde British theatre director Joan Littlewood in her pursuit of the everyday and through his concept of 'fun', " Central to Brecht's theories on theatre, as a form of social communication was his understanding of the essence of theatre as 'fun'. To Brecht fun, rather than heroic seriousness, was crucial to any effective theatrical communication with the people."[17] Developing a concept of a people's theatre through which participation and collective engagement would self-regulate, self-organize and program the environment was to anticipate an inter-determinate and immediate architecture that would radically necessitate re-conceiving the terms of communication and control. Price writes, " The varied and ever-changing activities will determine the form of the site. To enclose these activities the anti-building must have equal flexibility. Thus the prime motivation of the area is caused by the people and their activities and the resultant form is continually dependant on them."[18] Price's insistence to describe the *Fun Palace* as an anti-building was a spirited and calculated act, as architecture understood within this framework would by necessity challenge the common conventions and terms

17 Mathews, S. (2007a) *From Agit Prop to Free Space: The Architecture of Cedric Price*. First edition. London: Black Dog Publishing.

18 Ibid.

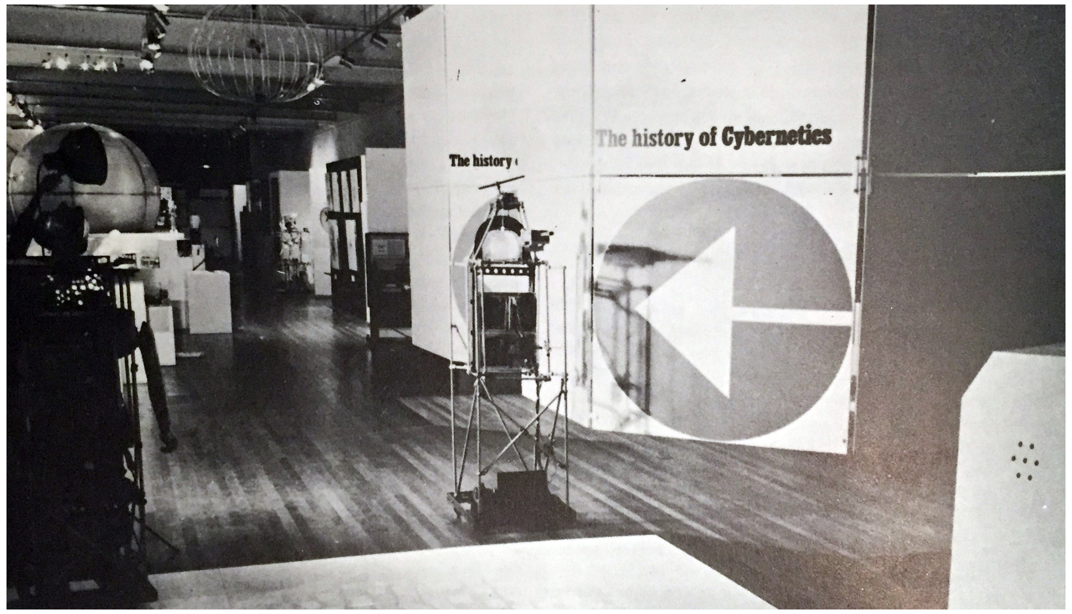


Figure 66: Cybernetic Serendipity, ICA London, 1968

Seminal exhibition assembled an inter-disciplinary collection of art, design, concrete poetry, music, computer science and cybernetic machines within one shared format.

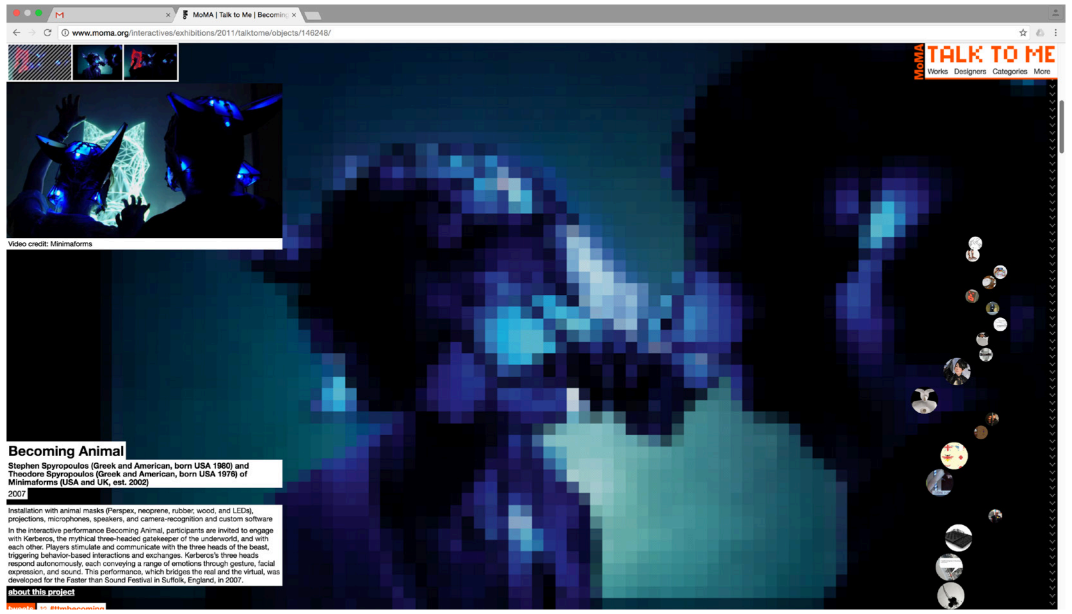


Figure 67: Becoming Animal, MoMA: Talk to Me, 2011

Authored transitional experiment was featured in Paola Antonelli's MoMA exhibition titled Talk To Me.

of communication. The architecture was not in the "stuff" or the programming, it did not have a fixed plan or form and so demanded a new framework to discuss a time-based formation that was stimulated through participatory and collective forms of systemic control. Price himself understood that a project like *Fun Palace* would need to find a systemic foundation and he sought to explore this through cybernetics and game theory. Reyner Banham may have said it best when in speaking of the *Fun Palace*, when spoke about Gordon Pask, "Pask was fond of saying that if it did not kick you back it was not interactive. The Fun Palace however, stands at least as the acknowledged first actively interactive environment-it would literally move and change in response to the desires of the users."[19] An anticipatory architecture identifies time as a medium and key architectural control parameter. The spatial concept is open by design to allow the possibility to address latent and otherwise unknown conditions. Novelty evolves through participation over time constructing personal relationships within a framework of conversational interactions. Materiality moves towards transient and ephemeral atmospheres, exploring phase change and instantaneous properties that are sensitive, responsive and adaptive. Structure is seen as something malleable and mobile. This could be seen in radical conceptions of architecture for example in the collaboration between Yves Klein and Claude Parent. Klein and Parent in developed in a similar spirit to Price's Fun Palace a radical proposal constructed as an atmosphere of what they termed "*Air Architecture*". Klein wrote that "theatre would then be the tangible, material, emotional, and spiritual everyday life and each person would become both actor and spectator. The theatre would no longer exist as an artificial world set apart, it would be everywhere at the same time since we would have reached the end of the cycle of involution - evolution throughout the world of transient psychology..."

19 Ibid

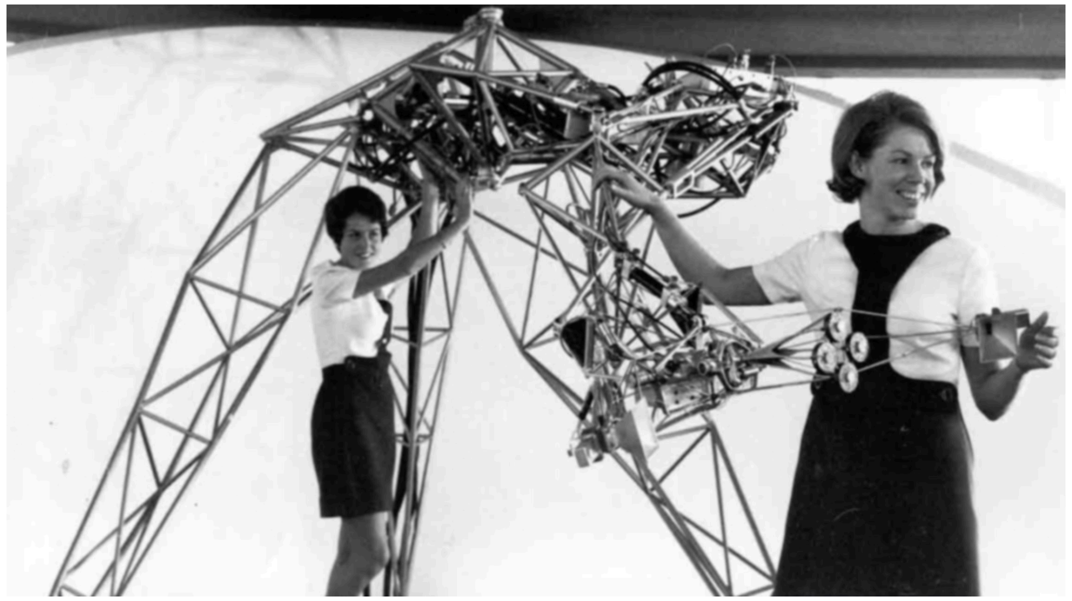


Figure 68: Edward Ihnatowicz, Senster, 1970-1974

Senster was a landmark cybernetic sculpture developed for Philip's Evoluon, in Eindhoven, Netherlands. The sculpture explored animalistic behaviours exhibited through kinetics. It remains a key example of Human Machine interaction.

[20] The desire to consider architecture as transformable, adaptable and evolving framework was at the heart of Avant guard projects of sixties and seventies. This thesis in the same spirit has attempted to challenge the framework of what architecture could be from atmospheres in works like *Memory Cloud* to behavioural robotics in the concluding work in thesis *Petting Zoo*. In considering thematics such as novelty and play one can see that the concept of the game as ordering system figured prominently in the design systems of Price and Ascott's theorization as an approach to produce novelty and elicit behaviour.[21] Pask in considering the psychology of pleasure wrote, "Man is prone to seek novelty in his environment and, having found a novel situation, to learn how to control it." It is through this evolving behavioural exchange that novelty has the potential to stimulate interest and understanding.

Cybernetic Machines: Prototyping Behaviour

The Human Machine framework is predicated on the construction of behavioural machines. Machines in this chapter have been designed to exhibit attributes and embody life-like characteristics that stimulate human engagement. Beyond kinetics these machines exhibit agency and project an observable intelligence to human participants. It is of interest to consider for a moment some of the formative cybernetic and systemic conversations discussed at the Macy's conferences (1946-1953) that included participants Norbert Wiener, John von Neumann, William Ross Ashby, Margaret Mead, Gregory Bateson, Heinz von Foerster, Claude Shannon amongst other distinguish scientists, anthropologists, and cyberneticians. In particular during the 8th Macy Conference in 1951 when pioneering information theorist and mathematician Claude Shannon

20 Yves Klein: Air Architecture, eds. Peter Noever and François Perrin (Ostfildern-Ruit: Hatje Cantz, 2004

21 Ascott, Price and Pask would work together in developing the Fun Palace. Ascott was invited by Pask and Price to join their Cybernetics Committee. Ascott developed for the project a concept titled *Pillar of Information* that would serve as a database for the public.

demonstrated Theseus, an electromechanical "mouse" that occupied a 5 x 5 square grid maze. The matrix itself was a reconfigurable partition system that constructed multiple scenarios for the "mouse" to explore. The mouse designed as a small vehicle and enabled by a simple sensing device would be able to track its position relative to its search mode, scanning the corridors until reaching its successful exit (goal) of the maze. The mouse would exhibit a form of memory through its history, understanding its position relative to its explored territories. Demonstrating a form of learning the mouse would solve the maze problem and exhibit an artificial form of intelligence. This learned behaviour allowed the mouse to move between exploratory and goal oriented strategies that built up a model for action in the environment it was participating in.

Professor John Johnston of Emory University states that, "while no one could or did confuse the behavior of the "maze-solving machine" with that of a real mouse, the similarities between the two were uncanny. In fact, most of the machines built by the cyberneticists exhibited behavior that if witnessed in living organisms, would be deemed intelligent, adaptive, or illustrative of learning. Hence the discussion at the Macy Conferences often revolved around questions of whether these machines were models or mere simulations, in the pejorative sense of giving only the appearance of something."[22] These projective qualities were articulated in-depth in Valentino Braitenberg's seminal publication *Vehicles*. Braitenberg's argument made a simple though profound correlation through thought experiments of vehicle scenarios that were constructed through simple sensory-motor connections. These scenarios he would argue could communicate aggression, love or fear through observable cognitive behaviours exhibited through interaction. This projective human quality plays an important role in the

22 Johnston, J. (2008b) 'The New AI: Behaviour-Based Robotics, Autonomous Agents and Artificial Evolution', in *The Allure of Machinic Life: Cybernetics, Artificial Life, and the New AI*. Cambridge, Mass: The MIT Press, pp. 337–384.

development of the authored experiments of *Becoming Animal* and *Petting Zoo* featured in this chapter.

Cybernetic experiments such as Grey Walter's Tortoises or Nicholas Negroponte's (AMG) *Seek* evolved further some of these issues brought about through Shannon's mouse, by introducing multiple participatory agents and dynamically responsive environments. The discussion of model vs. simulation relies greatly on ones argument and emphasis of agency and observed agency within a system. It is predicated on whether you believe intelligence is an attribute to a thing or a product of behaviour between things. The Architecture Machine Group in the early seventies framed the conversation by articulating the differences between systems that "problem solve" and those that "problem worry". The first ascribing a found (programmable) knowledge to an agent while the latter allowing the agent to source its response through direct interaction with an environment. This being a classical AI dilemma illustrated most directly in the research at MIT of roboticist Rodney Brooks who developed robots from both sides of the intellectual divide. His emphasis-focused on the agency of the thing itself and its relationship to its environment. Early robots developed in Brooks research simulated through mapping their environments that served as the information model for which an action would be based on. This system would model the environment through symbolic representations prior to acting in the environment. This slowed the systems capacity to respond and operate within an environment. With great frustration Brooks took a radical break from this approach to his robotic development and like Braitenberg developed a concept for a reactive and reflexive framework for his robotic developments. In 1986 Brooks articulated what he called "subsumption architecture" which argued for a behaviour-based approach for processing information that was based on real-time interaction. This approach addressed embodiment and emergence through a situated conception of AI. This framework moved away top down control systems as demonstrated in the early systems to bottom up real-time response systems that were behaviour based. This model underpins systemic singular vs. collective self-organising attributes that will be discussed at length in the concluding chapter.

Cybernetician Dr. Ranulph Glanville articulates the dilemma further by making the motivation of the distinction an important tool in adopting a strategy that embodies “models of” and “models for.” This distinction through motivation and the abstraction that it affords includes observer parameters to be reintroduced through second order cybernetic principles. “Models of” fall into a representational mode, while “models for” are operative and address the performative and behavioural capacity to adapt and engage the complexity of a given situation. In considering an intelligent architectural environment, Glanville reminds us that, “the behavior of each, which, in interaction, gives rise to the recognition of the quality intelligence, takes place in the space between each: the space of interaction (the interface space) where each meet and can act, space as interface.... Intelligence is, I have argued, a quality attributed by one to the other in an interaction. Intelligence requires interaction and is shared: it is found in the contribution of both participants and is held between them.” The discussions of models vs. simulations initiated in the early meetings of the Macy Conference continue to challenge the conceptions of machine intelligence and responsive environments today.

Figure 69: Becoming Animal

Life-like attributes engage man in novel communication enabling active observation, evolving conversational forms of systemic play. Participants are performers co-evolving a process of becoming.

PROTOTYPING DESIGN: BECOMING ANIMAL

Concept:

Interests to explore agency within a design system had led to an important and transitional experiment titled *Becoming Animal*. The work itself developed out of a series of questions that had been raised in my research after completing the first two experiments *Facebreeder* and *Memory Cloud*. These two works identified a system that expressed and amplified contributions of participants and the effect this had within a design environment that was shared as an experience spatially. The *Human Human* communication expressed through the system afforded an animation of the environment and stimulation of social "human" scenarios that were a product of this experience. This exhibited what I have called "collective mirroring". Participants through their contributions within a real-time environment could contribute, observe and project themselves while simultaneously witnessing the behaviours of others within a public space. Human-to-human communication was observed through these works and new questions arose of how a system rather than an apparatus for human expression could exhibit their own behaviours. How would these behaviours be expressed and how would human participants receive and respond to these behaviours? The agency of the system itself would have to be explored to further consider how interaction and experience could evolve our relationships with space and things themselves.

Figure 70: William Blake, Cerberus, 1824-27

From illustrations to Dante's **Divine Comedy**, photo © Tate, London 2010

The attention of the thesis highlighted in this chapter therefore shifts its attention to *Human Machine* interactions. Conceptualising agency necessitates the design capacity of the system itself having the means to form a relationship and understanding with its environment. From a design perspective the system has to observe in some capacity and synthesise real-time information that would form the basis of its behavioural communication. The role of real-time processing and communication posed particular challenges that necessitated active proto-typing to test assumptions and highlight the communicative capacities of this framework. The initial research looked at developing sensing capabilities for the systems to able to construct a form of understanding. In a primitive manner the task began with camera based information streams that were mined for information. Initial experiments explored camera tracking and colour detection as instruments that would allow the system faculties to identify participants, their proximity and duration of engagement. An opportunity to test my assumptions came through an invitation to create an installation as part of Aldeburgh Music Festival experimental music platform *Faster than Sound*.[23] The context for this installation was to create a gateway entry piece within Bentwaters' Airbase existing K9 building that served historically as a home for military dogs. The concept behind *Becoming Animal* drew from this unique context by framing the intervention through the story of the mythical three-headed beast, Cerberus, guardian of the underworld. The narrative creating a scenography that would be inspired by the many stories of how the Greek heroes lulled the mythical beast to sleep through alluring movement and action.

The objective of the research was to create a real-time theatrical environment of performance through collective participation. Each participant's presence would stimulate the three heads of the Cerberus, triggering the possibility for behaviour-based interactions and exchanges. Interactions would be expressed through

23 Faster than Sound took place as part of the Aldeburgh Music Festival n 2007 in a decommissioned airbase (Bentwaters Airbase) in Suffolk, England.

sounds, facial expressions and activity of the Cerberus. Each head would be a back projection located within 3 of the five cages that constituted the space of the K9 building. The continued dialogue between users and the system would demonstrate emotive exchanges that exhibit expressions that could be received as love, anger and boredom. The system was developed to display what appears as life-like responses so as to enable playful interactions between participants and the projection heads as an experiment in communication, based on the human tendency to project life into forms that exhibit a complex and dynamic behaviour (for example, the tendencies articulated in the seminal works of Valentino Braitenberg's Vehicles and Walter Grey Walter's Tortoises).[24] In a Paskian sense of the theatrical, all participants within this environment would be potential performers. The goal was to setup a real-time environment that examined Human Machine interaction through real-time response.

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Figure 71: Becoming Animal Concept Sketch

The project explores the story of the mythical three-headed beast, Cerberus, guardian of the underworld.

DESIGN PROCESS

Becoming Animal developed through an attempt to animate these back projection heads in a way that could communicate to participants. In turn the system would also have to recognise human participation and make this meaningful through its interaction. To explore this the system would have to have a vision system to observe and stimulate real-time engagements with participants. As this was developed pre-kinect in 2007 the vision systems used camera motion tracking to recognise participants. The system would identify a number of participants through point light sources and identify and place their proximity in relation to the intensity of the light values received. The light values would be dynamically mapped and trigger the projection heads to respond through dynamic head movements, 3D facial expressions, sound and colour. These interactions would include three distinct types of exchanges: dog to user, dog-to-dog and user-to-user. Beyond passive models of observation found in the traditional context of viewing art, the system would actively participate through dynamic patterns of stimuli. In responding to this, over two hundred and fifty dog masks were created with embedded LED lights placed at the forehead of each mask.[25]

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COMMUNICATION FRAMEWORK

The communication framework explored in Becoming Animal examined how real-time feedback could trigger emotive responses exhibiting more nuanced and behavioural exchanges. Beyond reactive systems the research sought to find through coupling of movement, sound, colour, duration and illumination a rich palate of possibilities to explore more truly interactive communication. For example the colour red when coupled with more animated or spastic projection head movement and raised volume could exhibit more agitated or angry emotive features. Point leds where used to identify individual participants and develop an interface that measure light intensity and transcode this information into colour values, audible intensity and facial gesture control of the 3d mesh of the cerebus.

Becoming Animal Emotions:
Sad (colour, sound, facial gestures)
Happy (colour, sound, facial gestures)
Angry (colour, sound, facial gestures)
X no.___ person = X no. ___ point lights

One Person Interaction Scenario Notes
Following behaviour / low noise / Dog should become playful / aggressive (noise levels rise from low to medium) Wireframe should change colour gradation from white to blue (should have a bluish glow to communicate happiness) (Happy dog barking samples triggered)

If participants' movement is quick or if the person moves for a continuous duration (10 - seconds) the Dog should get threatened and exhibit angry tendencies. (Colour gradation should change to red to heighten extreme anger) noise levels change from medium to high) / Angry dog barking samples triggered / If a participant stands still for five or more seconds the Dog should lose interest … (colour should morph to white) / sound levels return to low / dog could scale down, possibly disappear?

Two –Three Person Interaction Scenario Notes
The dog should track one participant at a time. The same rules as one person tracking should apply. Every 5 seconds the Dog should shift focus to one of the other people being tracked..
For example Dog focuses on tracking person 1 for 5 seconds, then switches focus to person for 2 for 5 seconds, then focuses on person 3 for seven seconds, then switches focus back to person 1 for 5 seconds and so on / Dog should be more inclined to exhibit happy emotions. Probability ratios leaning to this behaviour.

Four to Seven Person Interaction Scenario Notes
The same rules should apply as 2-3 person interactions but the Dog should be more inclined to get frustrated easier / More inclined to show agitation and heightened awareness of the crowd… angry emotion and volume control to fluctuate between assertion and submission regarding the duration and exchange / Durational mapping of crowd

Eight + Person Interaction Scenario Notes

The Dog should no longer track individual people's movements and should switch to "crowd - simulation mode", as this will be too complex to partition within the resolution of the camera frame and will offer meaningful responses. Random aggressive facial gestures could be triggered in this mode based on sustain durational influence. Facial features should exhibit more overwhelmed communication and oscillate between assertive and submissive tendencies to incite possible reaction in participants' behaviour.

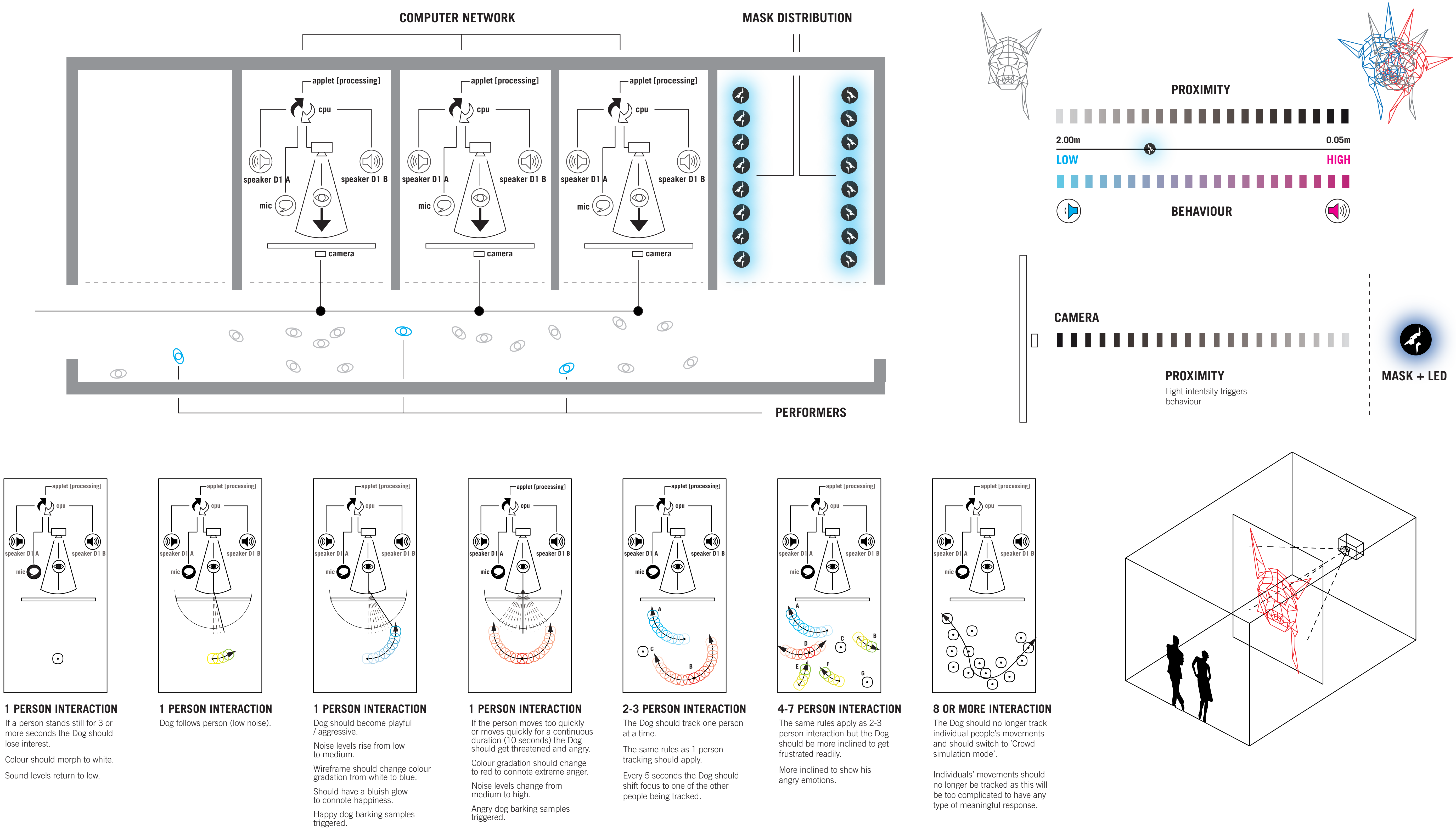

Figure 72: Becoming Animal Mapping

Becoming Animal used motion tracking to recognise participants through light. The system would identify a number of participants through point light sources and identify and place their proximity in relation to the intensity of the light values which would in turn be dynamically mapped.

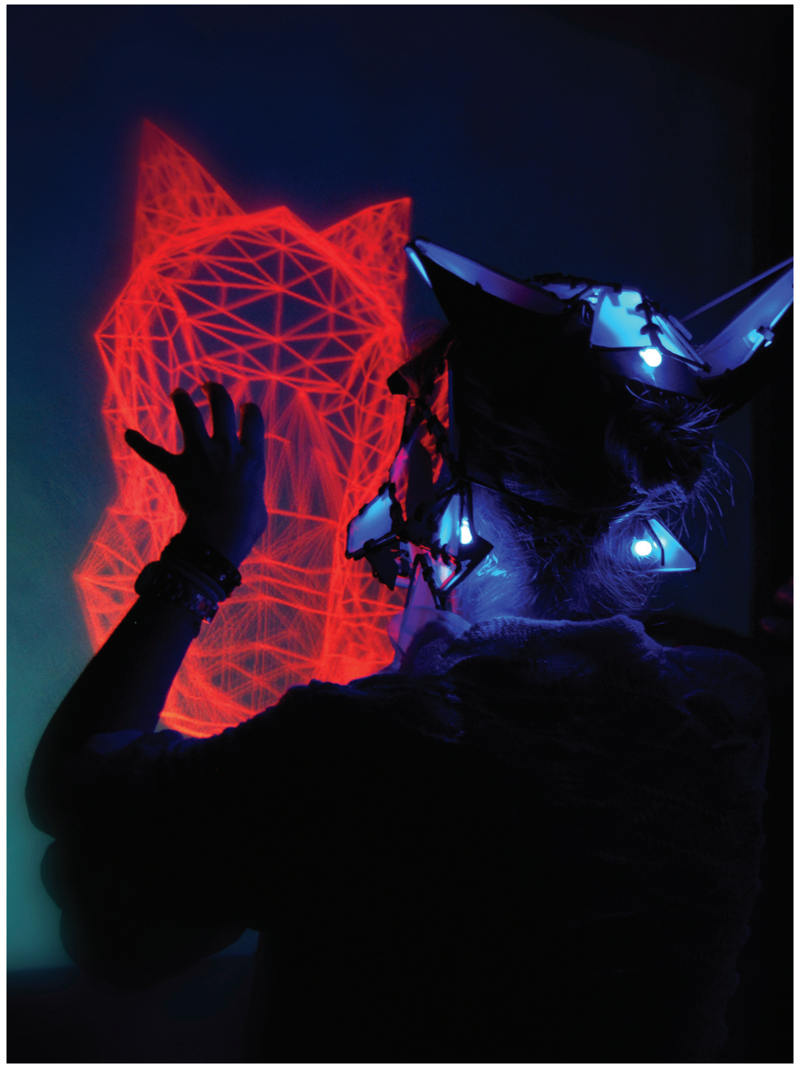

Figure 73: Participants Become Performers

Becoming Animal was developed as a theatrical experiment where the participants would become performers. The piece used masks as an enabling and interactive medium.
The masks would stimulate the projection heads as part of one continuous evolving and shared experience.

Figure 74: Becoming Animal

Beyond the passive models of observation found in the traditional context of viewing art, the system would only actively participate through dynamic patterns of stimuli.

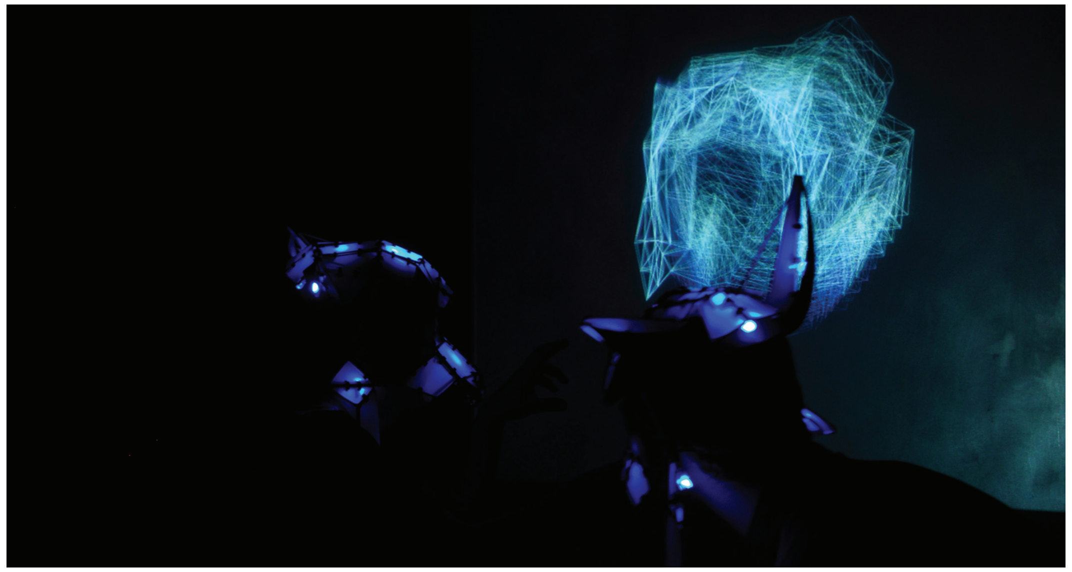

Figure 75: Evolving and Shared Experience

Becoming Animal used motion tracking to recognise participants through light. The system would identify a number of participants through point light sources and identify and place their proximity in relation to the intensity of the light values which would in turn be dynamically mapped.

Figure 76: Mask Production

Two hundred and fifty masks fitted with point LED lights were constructed and handed out at the entrance to the exhibition space.

PROTOTYPING

Prototyping Becoming Animal was explored through the development of custom software, enabling props and large back projection screen design. The interplay between the software development and the design props in particular afforded an exciting observation and lessons in the development. I will elaborate on this in the observation section of this chapter.

The main efforts and time spent in this project were in the framework for this experiment that would server as a recognition system that would allow the system to distinguish participants and track them. This would allow for events and emotive features to be triggered as a product of this observable understanding. A web camera was used to detect point LEDs that would register as 2.5D intensity maps that would give approximation of location and movement and through intensity values give proximity values. The development of the camera tracking gave robust results with limited point light sources (anywhere from 4-7). Calibration of the system offered a variety of spaces to be considered but due to the limited time to deliver the project a mock-up of the space was simulated to get a better sense of the possible scenarios that could influence the system. In developing the software of this system a great deal of emphasis was placed on movement of the point light source to trigger events. As the technical challenges in this project had a by-product of how I was developing the software using my hand gestures to stimulate the

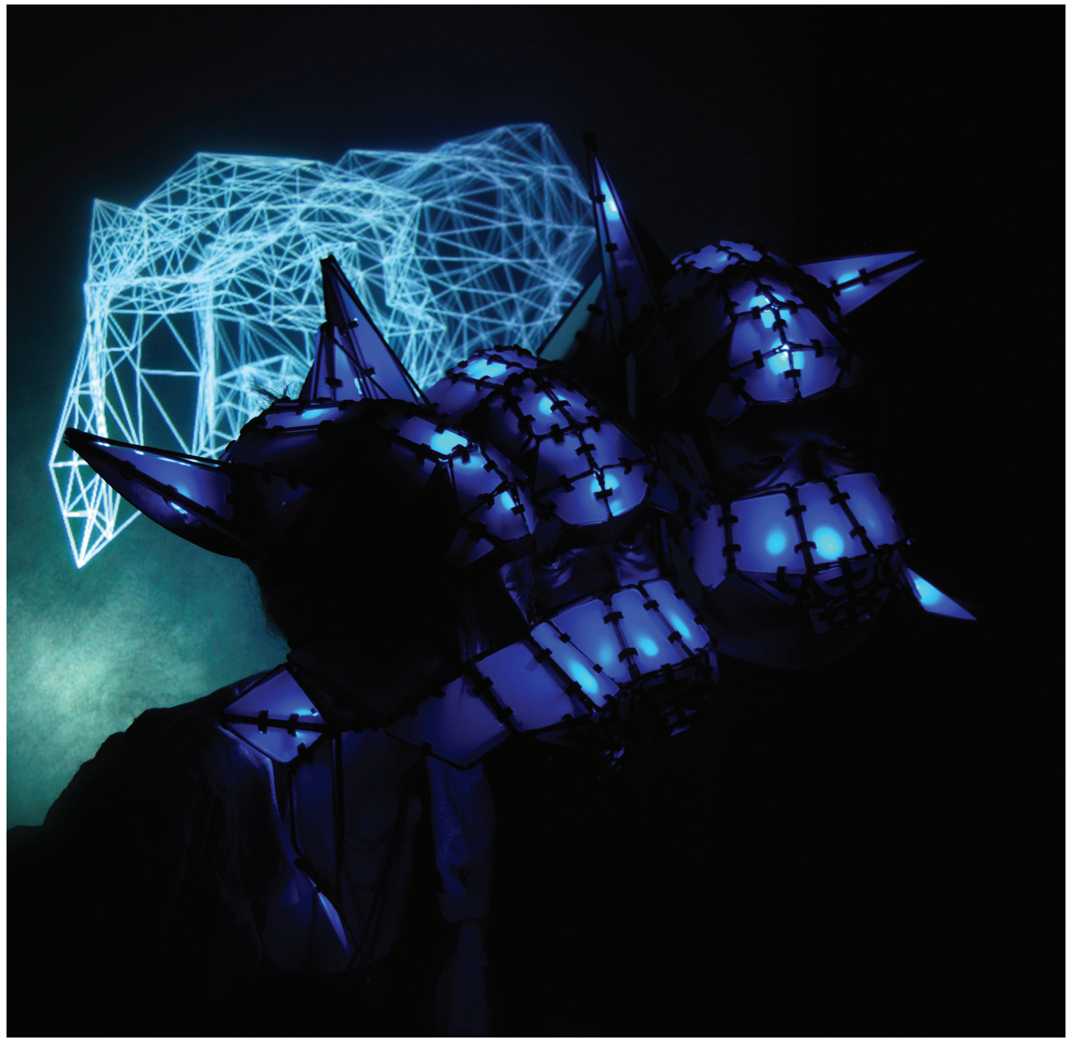

Figure 77: Real-Time Participatory System

The Greek myth of Cerberus conceptualised the development of a real-time participatory system that would co-evolve through time and interaction.

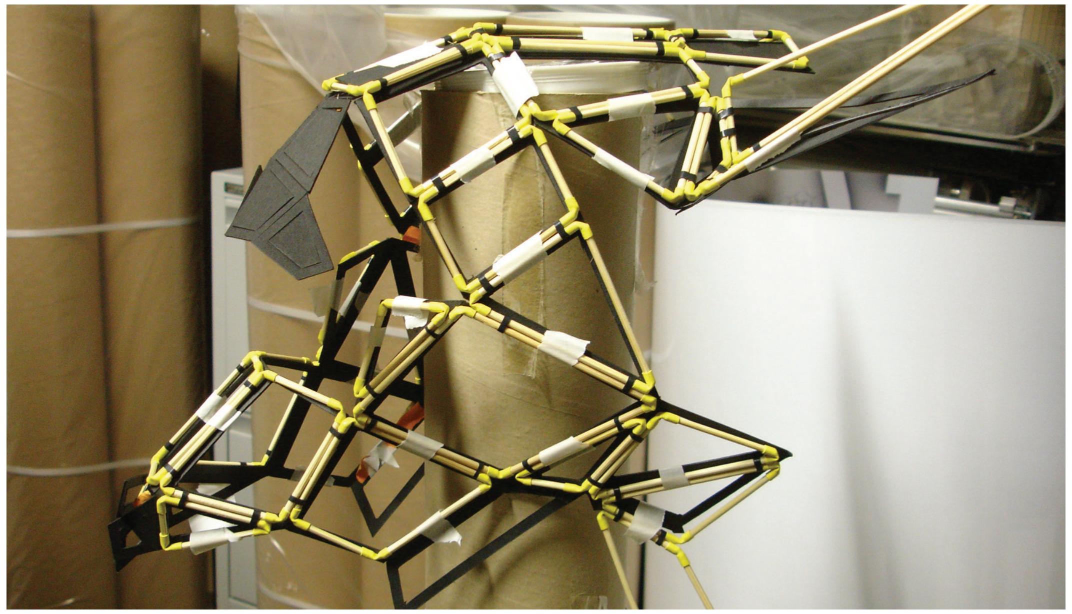

Figure 78: Mask Development

Obscuring recognition, the masks allowed participants to behave in an uninhibited manner, becoming performers in a theatrical system and exhibiting a collective playfulness.

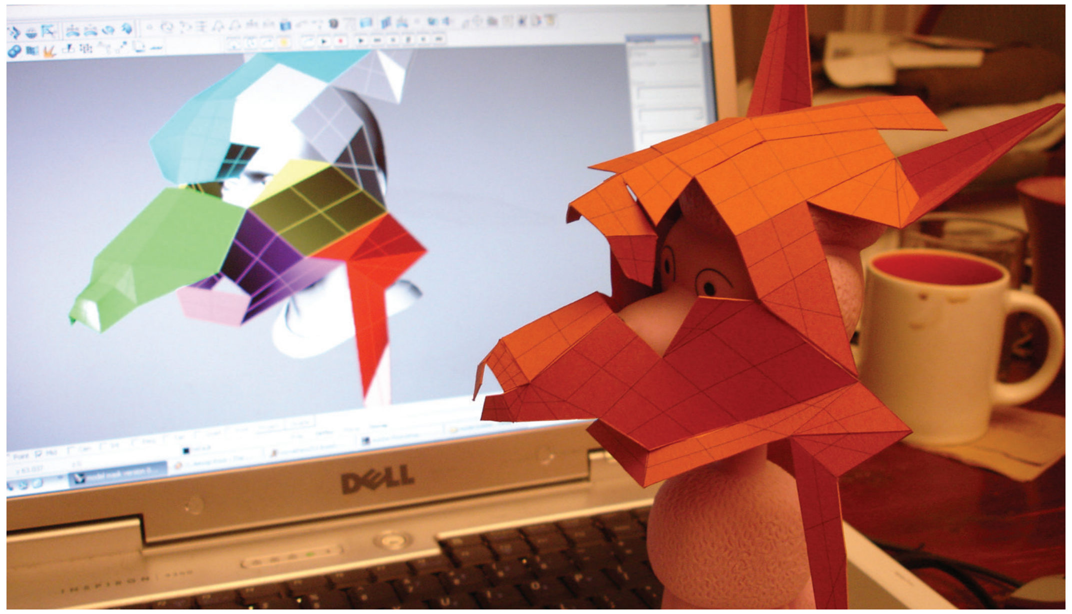

Figure 79: Mask Prototype

250 dog masks were created with embedded LED lights placed at the forehead of each mask.

system and interaction. This had particular consequences, as it was antithetical to the playful and theatrical nature of what the experience was conceived as. It was only through a reconsideration of the space of interaction did an analogue solution to the problem present itself.

The second phase of prototyping was to consider how visitors could become participants and performers in the system. Recognising in art environments that are dynamic, they have the tendency to influence more stationary observation in human participants. The move to engage passive to active observation looked to play as the stimulus to enable curious and engaged dynamic interaction. In considering the issues of dynamism that was needed by the system development and coupling this with the observer tendencies with in dynamic environments the project proposed to develop masks that would be located on the body that was animate and allow participants to behave in a more uninhibited manner. For the performance all visitors were given a dog mask to enter the space of the Cerebus. A total of two hundred and fifty masks were made in total. Each mask fitted with an LED in the forehead zone of the mask. The masks enabled a playful and stimulating interaction between people and the projection heads creating a theatrical space of becoming. Becoming animal.

Figure 80: Performer Masks

Three dedicated performer masks were constructed to further stimulate collective behaviour. These specialist masks were designed as a soft-frame helmet with in-built lighting controls.

OBSERVATIONS

Becoming Animal has served as an important transitional experiment in this research. It offered a way to consider play and real-time interaction as creating an experience that was at the same time individual and shared. In the theatrical tradition of interactive theatre, participants became performers within this evolving scenario engaged with human and machine stimulus. The project offered an interesting insight on the role of the technical and how interaction today could be reconsidered through more analogue means. As the project research mainly focused on the vision system and how participants would interact through this it was only when I considered the enabling performative qualities of the masks on participants that the project matured as a design experiment rather than a study. The argument here is not for or against technological drivers, rather an acknowledgment of design offering solutions that coupled together could create an exciting and playful environment. The project in its first and only iteration within this thesis opened up a new trajectory that embodied the desire for human machine interaction.[26] Through it's making a heightened awareness of how people can stimulate and in turn be stimulated through playful and more interactive means. Interaction here you could argue was facilitated by the masks more than any technical achievement of the vision tracking and event triggering. This is very important to state as the human faculty to engage and participate at times within space defaults into habitual response. It was through this *human human* and *human*

26 *Becoming Animal* was featured in an exhibit four years later in 2011 that was curated by Paola Antonelli called *Talk to Me: Design and the Communication between People and Objects*.

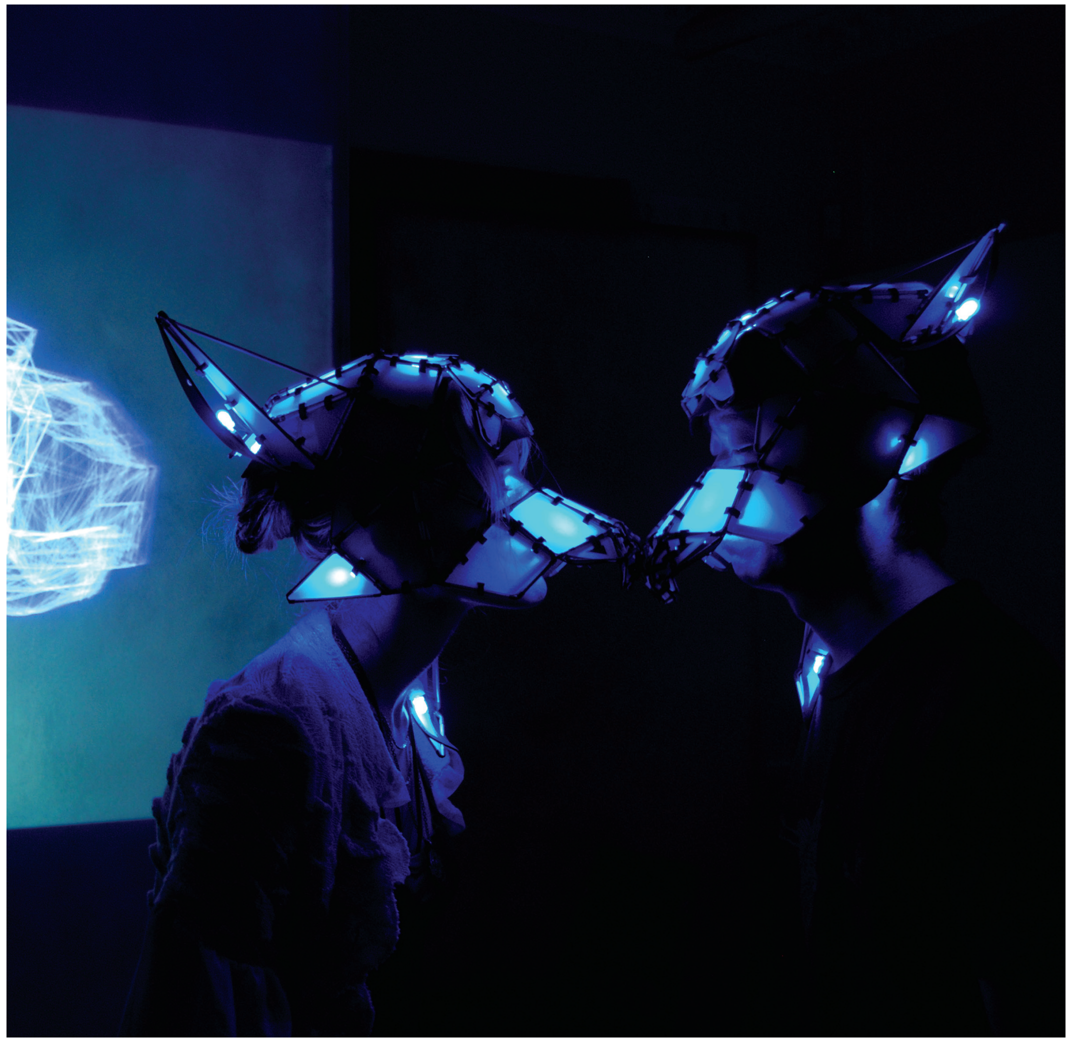

Figure 81: Playful Contact

Human-to-human interaction was heightened as masks enabled playful contact between the Cerberus and each participant.

machine interaction that the space transformed into a theatrical environment of stimulus and wonder.

The installation in many ways was successful in developing a proof of concept through the live experiment. In method the process developed highlighted the active conceptual frameworks that are needed to develop a behavioural approach to human interaction. Beyond reactive systems the ambition was given form of a dynamic series of interaction models that through spatial interfacing could construct an evolving conversational platform. In assessing this first iteration it was apparent that the installation at times was complex to the point of complicated. The sound sample triggers and other aspects necessitated further development. Overall the installation when occupied by fewer participants worked in a seamless manner where behavioural traits were recognizable and legible to participants. When the number or participants within the space escalated then the system did not have the ability or range to deliver enough variety to allow for meaningful difference. *Becoming Animal* raised many issues that informed Petting *Zoo*, a concluding major work within this thesis and the *Human Machine* research.

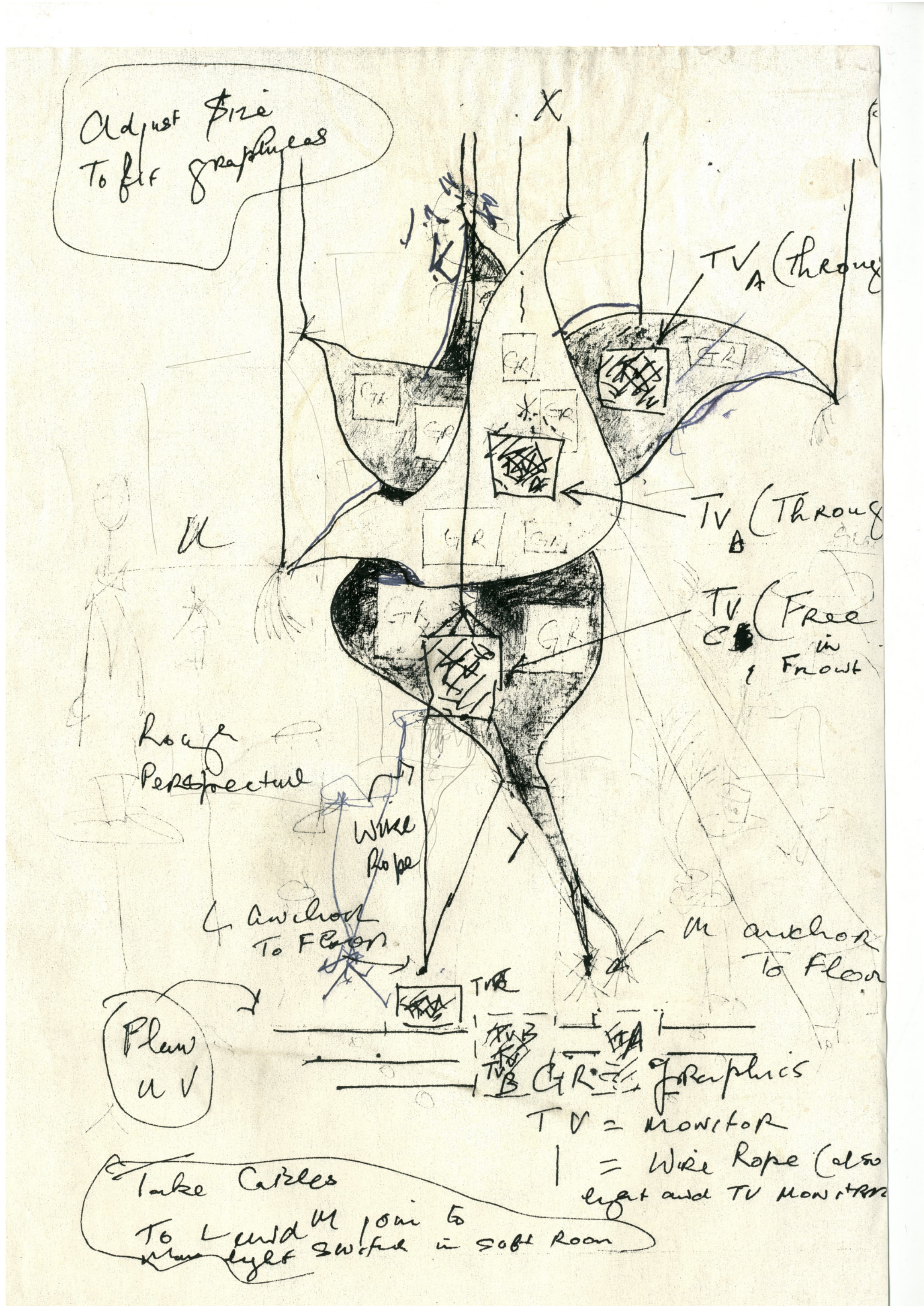

Figure 82: AA Archives Gordon Pask, “The Colloquy of Mobiles” Unpublished Drawing, 1968.

PROTOTYPING DESIGN: PETTING ZOO

“Cybernetic art is, by its very nature, immediately accessible, so much so that children are its most appreciative spectators.”

Edward Ihnatowicz, *Cybernetic Art a Personal Statement*, 1986

Concept:

Petting Zoo was conceived as a speculative robotic environment populated by artificial intelligent creatures that were designed with the capacity to learn and explore behaviors through interaction with participants. Within this immersive installation, interaction with the pets foster human curiosity, play, forging intimate exchanges that are emotive, evolving over time and enabling communication between people and their environment. The installation exhibits life-like attributes through forms of conversational interaction establishing communication with users that are emotive and sensorial. Social and synthetic forms of systemic interactions allow the pets to engage and evolve their behaviors over time exhibiting features and personalities that are formed through their interactions with the general public. Pets interact and stimulate participation with users through the use of animate behaviors communicated through visual, haptic and aural communication. Pet interactions are stimulated through interaction with human users or between other pets within the population. Using a real-time camera-tracking system that can locate people and

Figure 83: Petting Zoo, FRAC Centre

The project is speculative life-like robotic environment that raises questions of how future environments could actively enable new forms of communication with the everyday.

detect gesture and activity each pet has the capacity to process data so that they can learn and explore different behaviours by interacting with the public and each other. Over the course of the exhibition unique personalities are developed through human interaction enabling intimate and immediate exchanges that are playful, emotive and evolving.[1] These experiments are an exploration in artificial intelligence that prompts us to think about how we can coevolve and inhabit our future human machine environments. Moving beyond robotics understood as tools of production, Petting Zoo examines the emotive and behavioral features of our engagement with them and each other.

Early experiments can be found in seminal cybernetic work developed by British cybernetic sculptor Edward Ihnatowicz in projects such as the *Senster*, Gordon Pask's *The Colloquy of Mobiles*, and Walter Gray Walter's first electronic autonomous robots (Tortoises) called *Elmer and Elsie*.[2] Projects such as these sought to give their system agency. Through direct interaction with the world these agents could situate and respond to environmental stimulus. Each of this precedence explores kinetics as an enabling feature in how the work could exhibit life-like characteristics and how this could foster intimate exchanges with human participants. Edward Ihnatowicz argued that kinetics was fundamental to how we experience and understand things, when he state "It is my considered belief that most of our appreciation of the world around us comes to us through our interpretation of observed or sensed physical motion." Petting Zoo examines kinetics and gesture as a critical communication feature for the design and implementation of the design research. Duration and speed of movement offer communicative attributes that stimulate humans' varied emotive registrations. Through kinetics other attributes that such as audible and illuminative expressions further animate the potential forms of communication through their coupling. Petting Zoo continued the interest in real-time sensing and response that was initiated in precursor work such as *Becoming Animal*. Interaction within this framework examines Human to Machine interaction.

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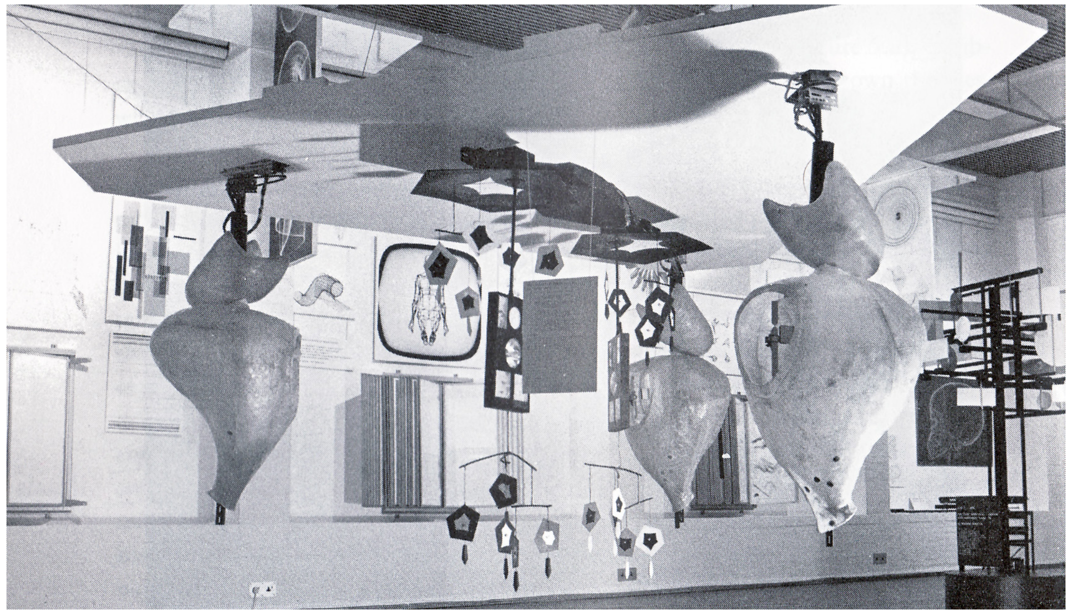


Figure 84: Gordon Pask, "The Colloquy of Mobiles", ICA London 1968

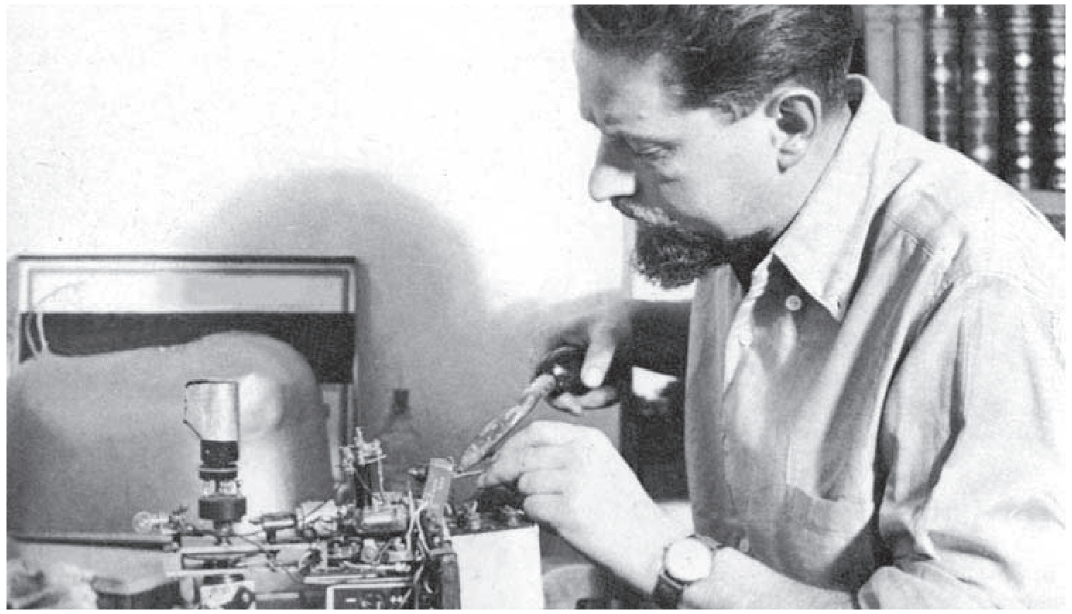


Figure 85: Walter Grey Walter, Tortoises

Early autonomous robotic pets.

Figure 86: Frame Development

Selection of images throughout the design and development of Petting Zoo

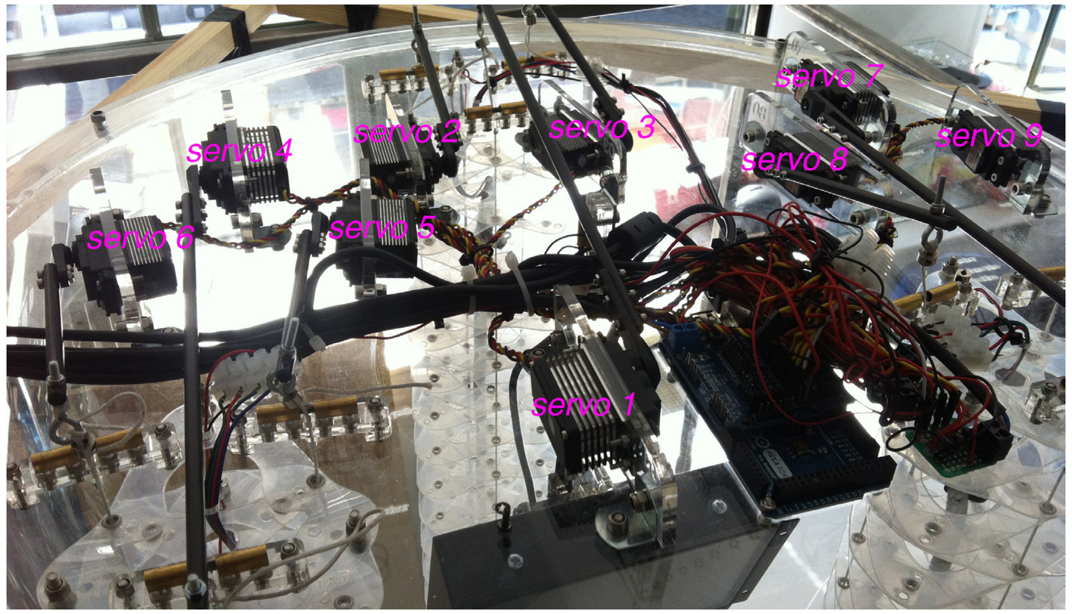


Figure 87: Networked Components

Selection of images throughout the design and development of Petting Zoo

DESIGN PROCESS

The design process examined digital analogue feedback in an attempt to explore real-time kinematic, audible and illuminative communication. To work through this process each strand of research was isolated and prototyped to articulate behaviours that would serves as triggers for further engagement. Making as a form of critical enquiry played an important role as computational frameworks and operable prototypes exhibited a process of designing, testing, observing and calibrating the system informed by this feedback. This iterative process opened up a palate of possibilities that could be explored. As the project progressed it was clear that a selection process that amplified results should be targeted. Differences that make a difference were pursued, as change in values did not always deliver in gestural response. The design process by necessity had to work on the development of an information architecture that would mine the kinect camera for meaningful values and transcode this into behaviours that could enable emotive signalling. Kinetic drivers included speed, duration, synchronicity and random movements. Illumination drivers included colour, intensity and pulsation. Audible drivers included generative breathing sound that for example amplified and accelerate the rhythm of breath when excited and changed intensity of volume.

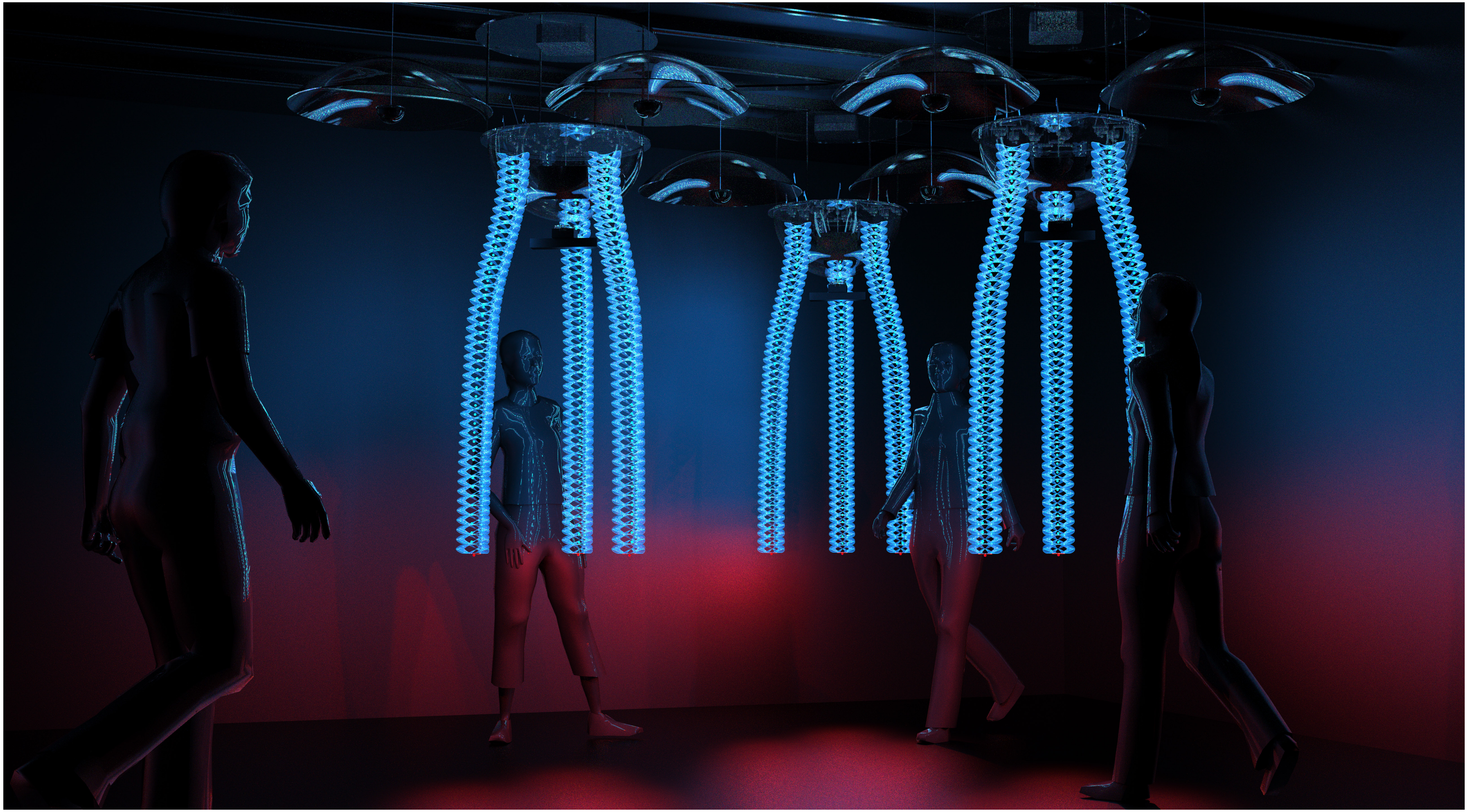
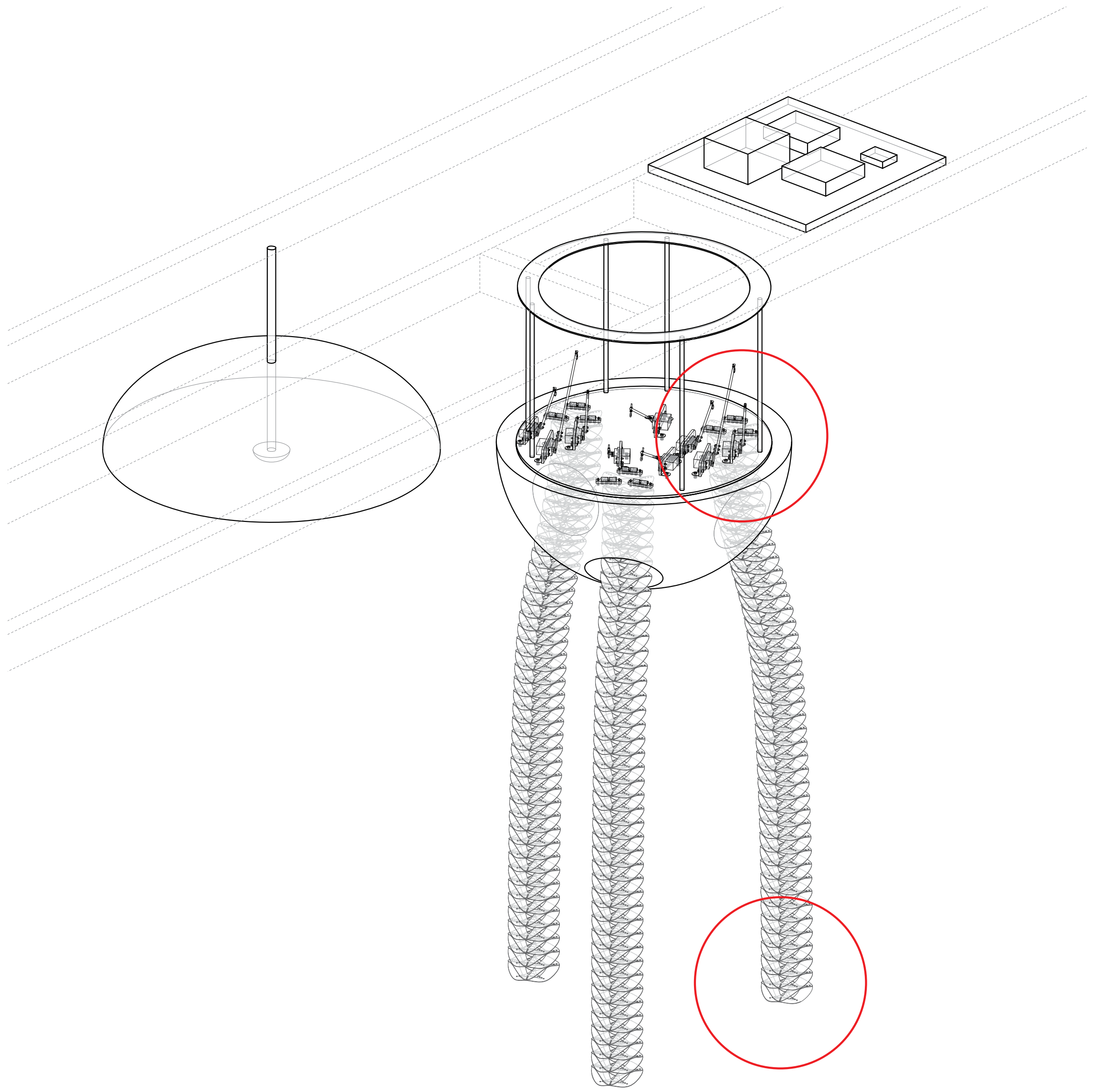


Figure 88: Concept Rendering

Selection of images throughout the design and development of Petting Zoo



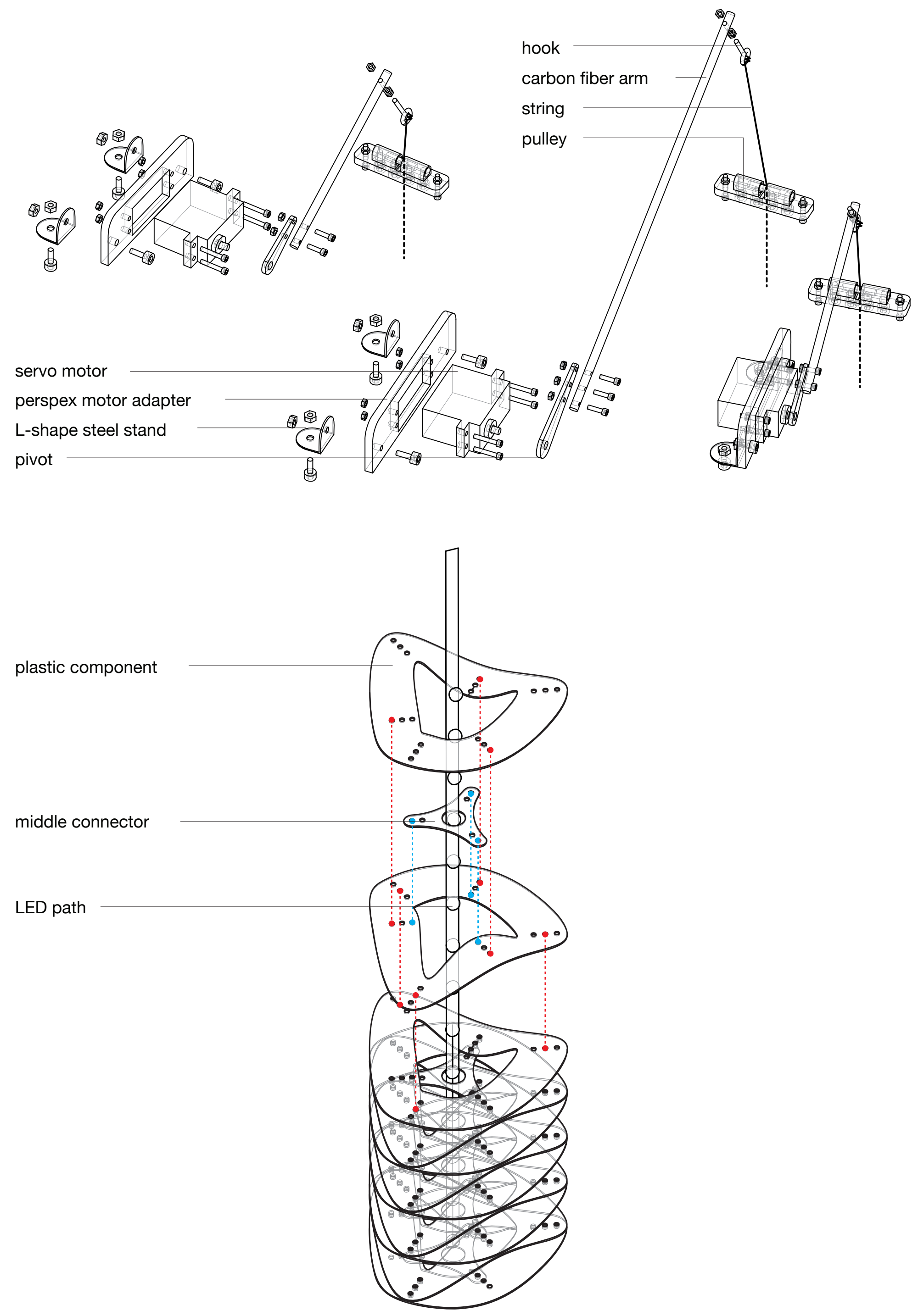


Figure 89: Component Design

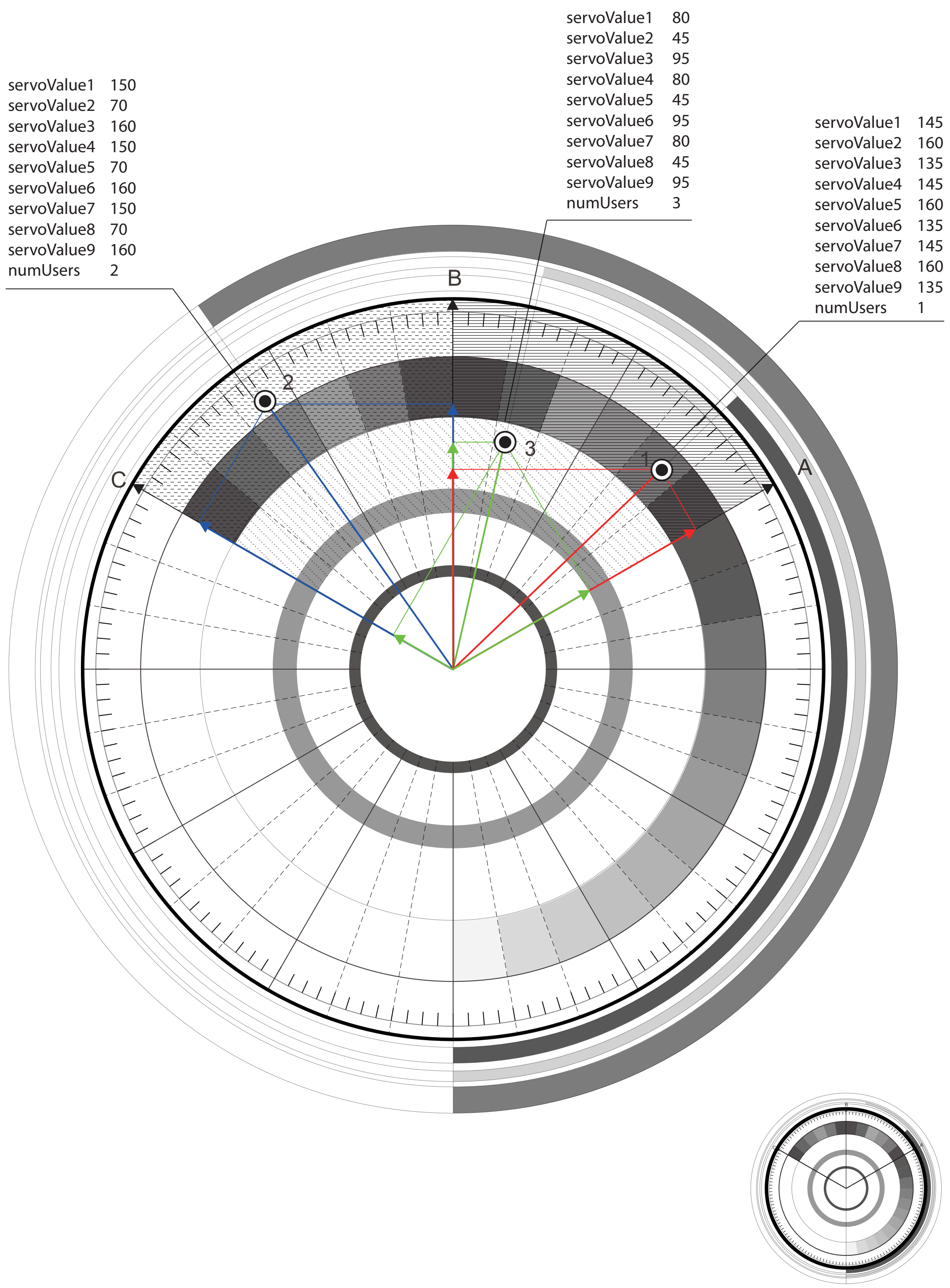


Figure 90: Behavioural Cognition

Pet system dynamically maps environment and recognizes participants through locative positioning and gestural behaviours. These patterns of interaction are stored short term and form a memory that informs the behavioural responses that communicate emotive characteristics.

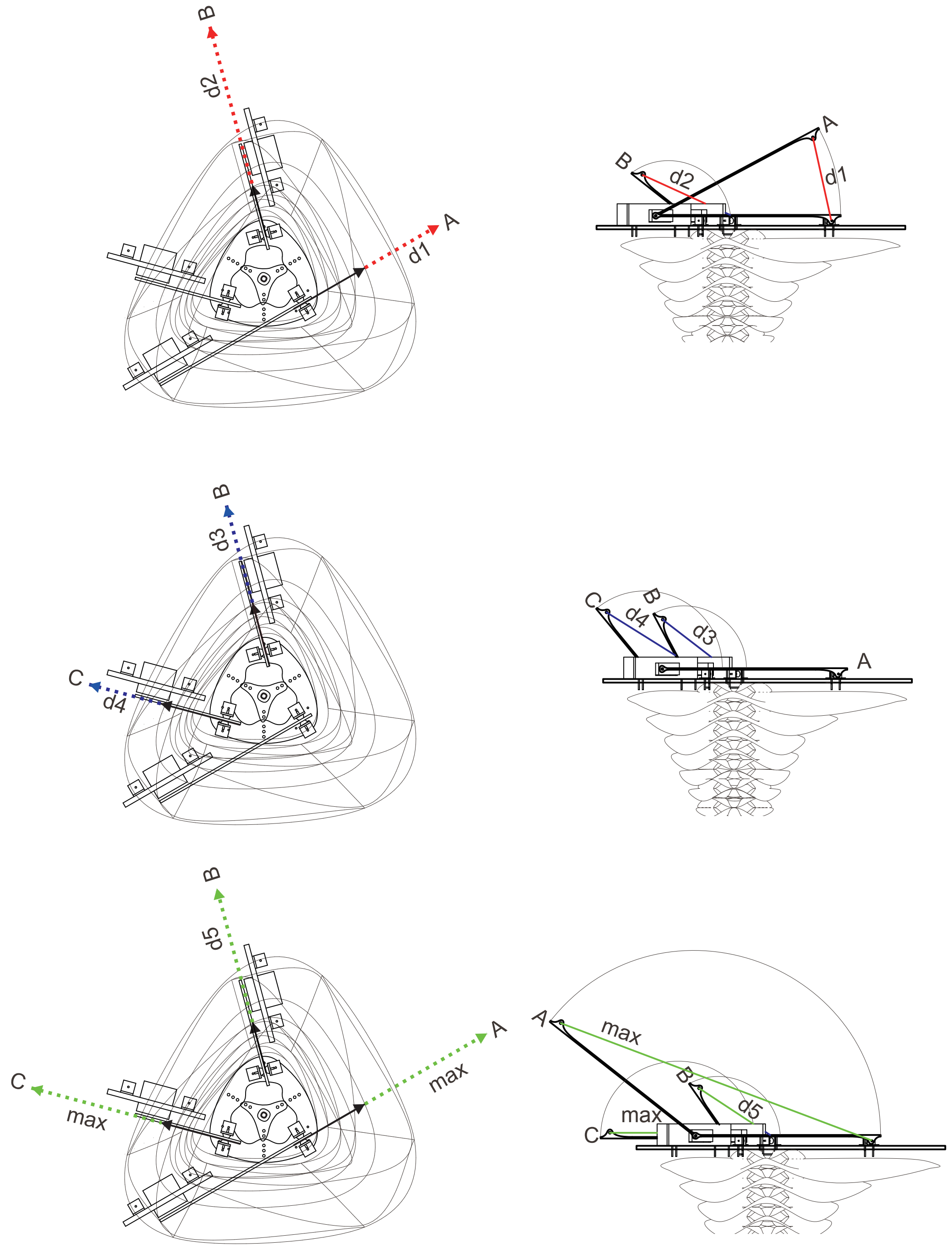


Figure 91: Mechanical Functionality

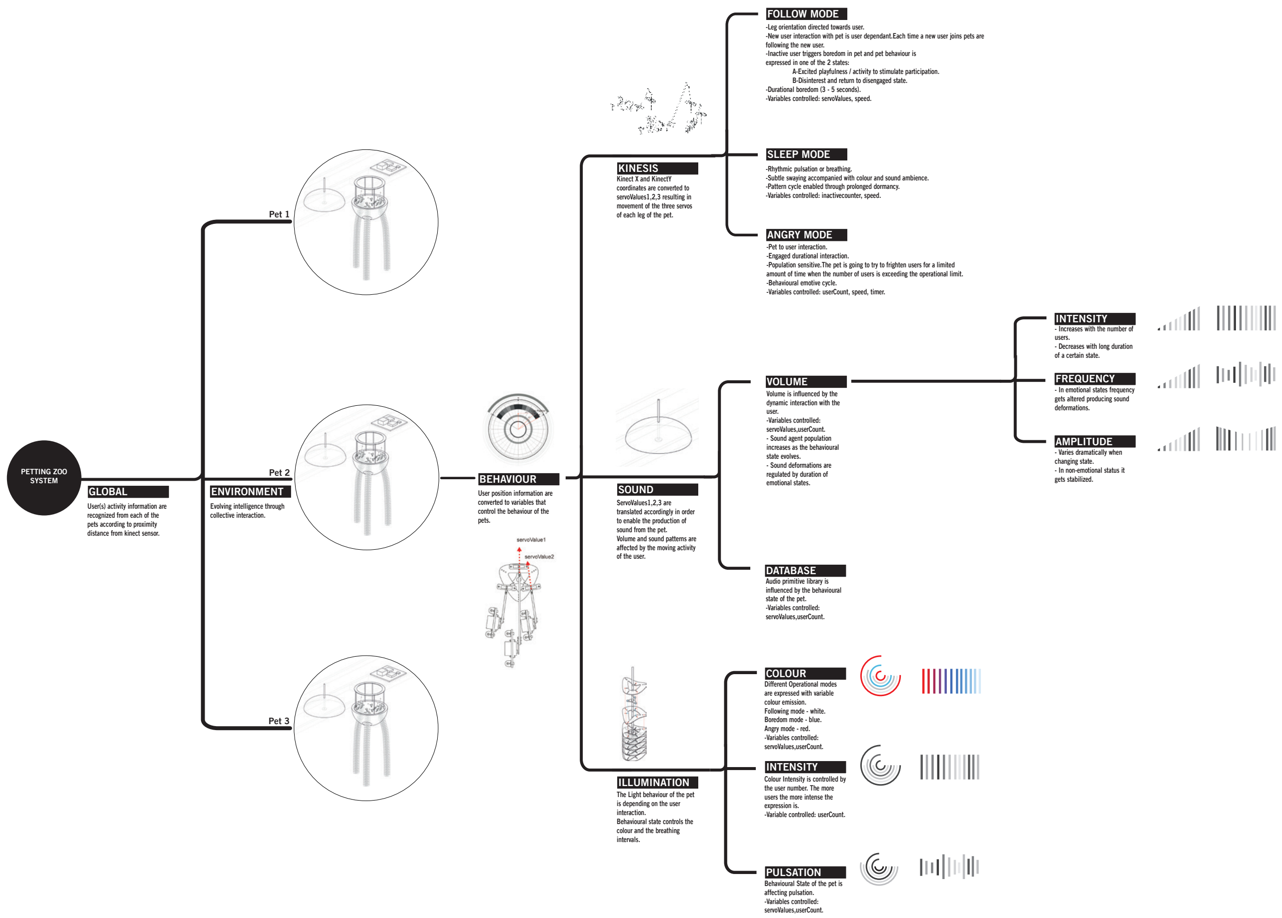


Figure 92: Systems Diagram

HUMAN MACHINE

COMMUNICATION FRAMEWORK

Awareness of participant(s) is enabled through a camera tracking / data scanning setup in response to contextual and environmental parameters. Live image streams are real-time processed and coupled with blob tracking and optical flow analysis to locate local positions and gestural activity of participants (crowd). Camera tracking will allow for consistent daylight and night time scenarios as well as detailed information of gestural responses.[3]

The interaction field between PETS and observers is in constant evolution. The observers are recognized by the system as passive or active following proximity rules. Following the data gathered form the location and the behavior of the observers the field change configuration creating clusters of influence with different directionality and intensity inputs for the PETS. The individual PETS select the closest observer to generate their movement. This selection is updated in real time with the variable position of groups of observers.

The PETS will have different lengths and mass. Their stable spatial location and the instable nature of the observers' dynamics will determine a variable field of proximities and areas of influence that will cause different degrees of activation and movements by the PETS. The overall field is then a stratification of two main generative reactions:

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HUMAN MACHINE

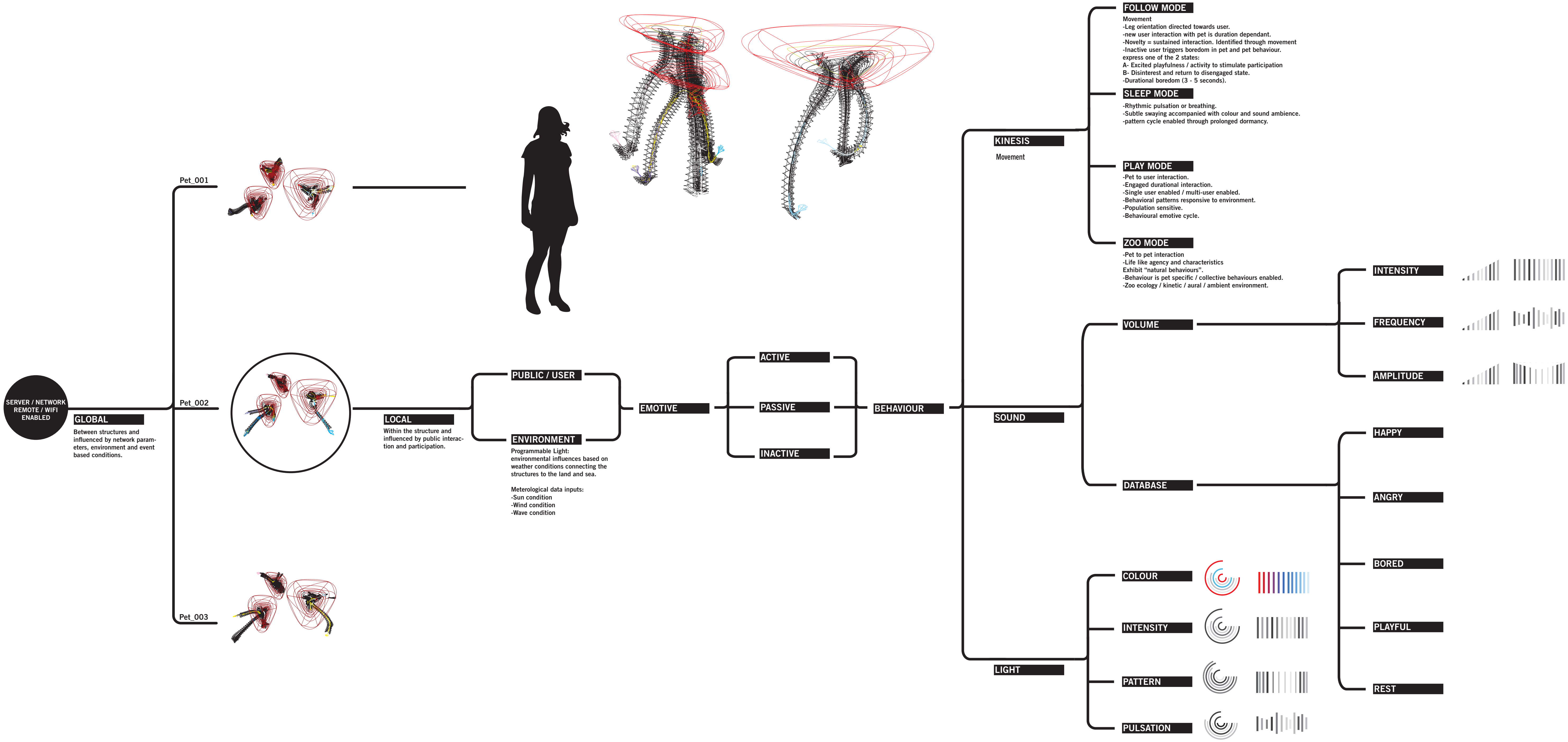


Figure 93: Operational Diagram

Awareness of participant(s) will be enabled through a camera tracking / data scanning setup in response to contextual and environmental parameters. Live image streams are real-time processed and coupled with blob tracking and optical flow analysis to locate local positions and gestural activity of participants (crowd).

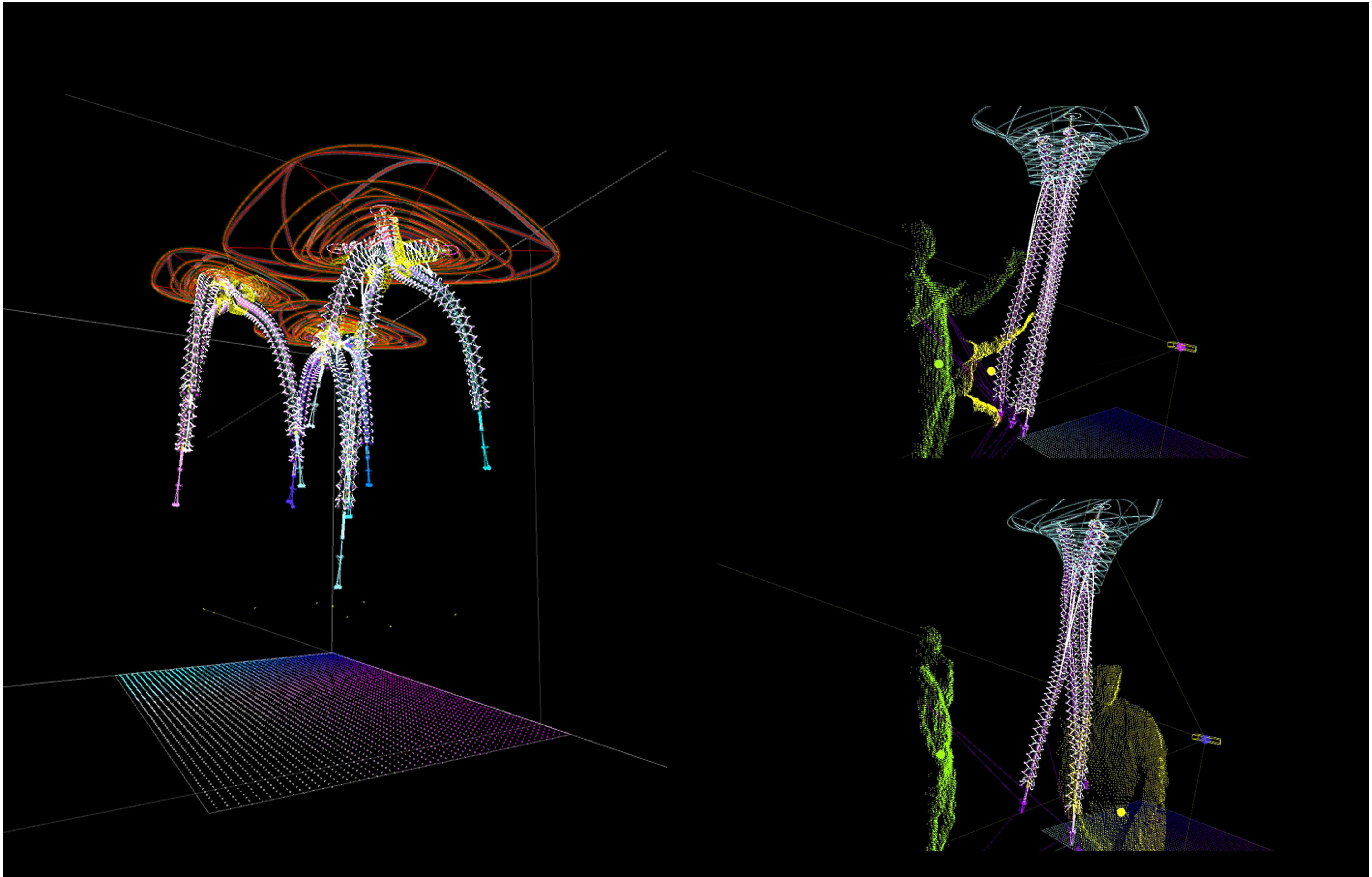


Figure 94: Point Cloud Mapping

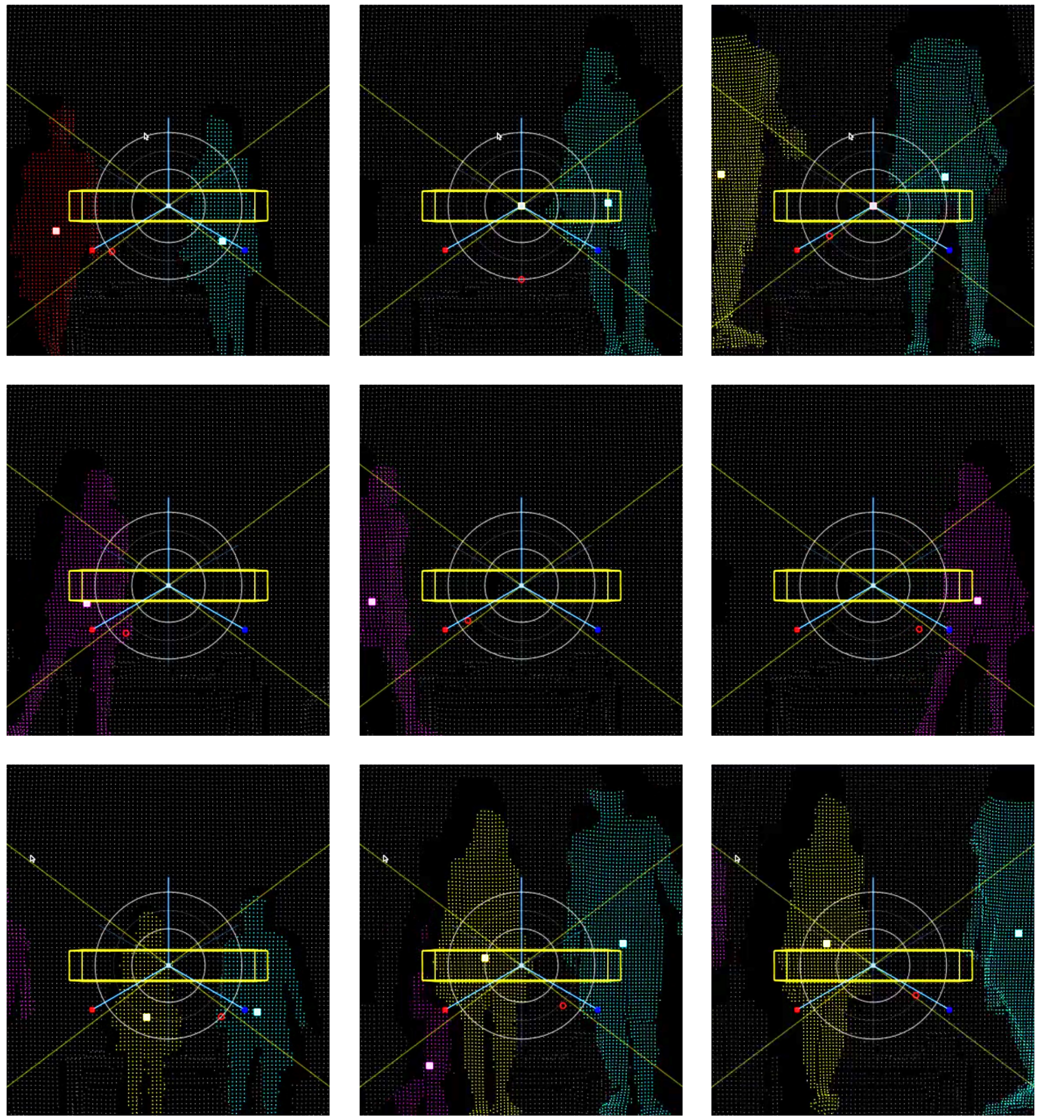


Figure 95: Vision System

Camera tracking will allow for consistent daylight and night time scenarios as well as detailed information of gestural responses.

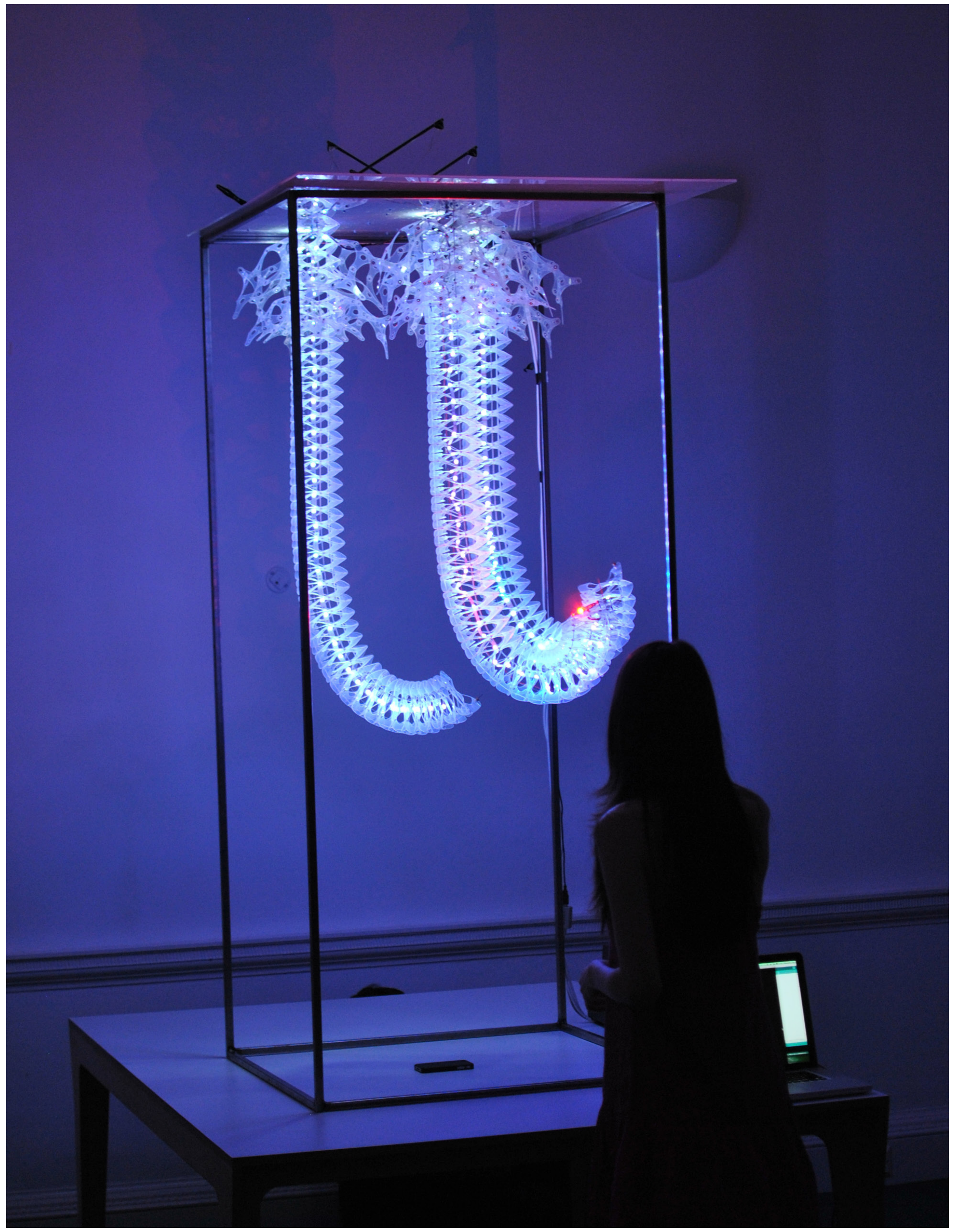


Figure 96: Petting Zoo Prototype

The pets are developed to be able to learn and respond to their environment. Rather than being reactive sculptures they will adapt and sense pattern that will form the basis of their respective behaviors.

1. Areas of influence, which will generate the selective directionality of the pets
2. Distance between observer and PET, which will determine the intensity of the PET's reaction

Each PET looks for the closest single observer or cluster of observers; the proximity and the number of the moving audience will create different weights of sensitivity. Within each area of influence there will be a gradient of excitement and mobility. The creature will show its interest following a numerical input coming from the layered field by increasing the frequency of the movement and by directional moves. The observers' movements will create a constant change and update on the interest shown by the PETS. Each creature is activated as a single individual and as a collective by participants' behavior and movement. The feedback is communicated as a resultant of three main actions:

1. Directional bending
2. Pulsation frequency
3. Illumination, color change

Behaviors

Internal patterns of observation allow the pets to synchronize movements and behavioral responses. Through active proto-typing a correlated digital / analogue feedback has been developed to allow the system to evolve relationships that avoid repetitive controller tendencies.[4]

Spatial Interfacing

Awareness of participant(s) is enabled through camera tracking and data scanning that allows for identifying human presence within contextual scenes. Real time

4 Please note that this text, written by the author of this PhD, was first published online at www.minimaforms.com (copyright by Theodore Spyropoulos)

camera streams are processed and coupled with blob tracking and optical flow analysis to locate positions and gestural activity of participants. Inactive participation of a performer in the environment can stimulate responses of disinterest and boredom.[5]

Multi-User Interaction

Collective participation is enabled by the ability of our system to identify and real-time map the number of performers within a durational sequence.[6]

Components:

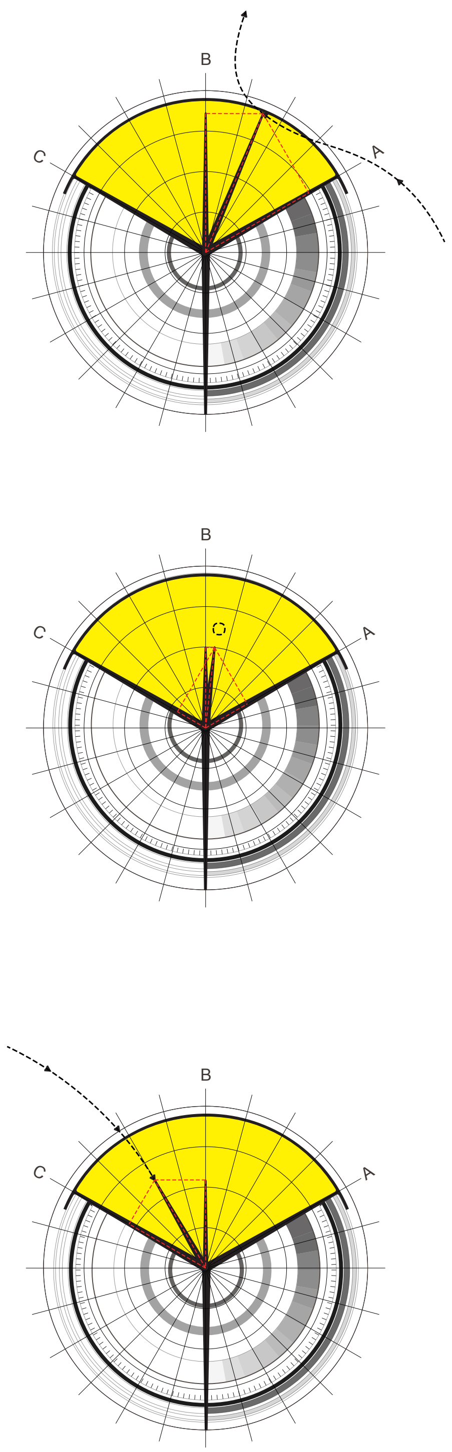
Physical Sculpture examines autonomous movement, user and multiuser interaction.
Inputs including location, touch, gesture based movements, multiuser interactions.
Various outputs examine sound, color, and luminosity.
Kinect - real-time data mapping[7]

5 Please note that this text, written by the author of this PhD, was first published online at www.minimaforms.com (copyright by Theodore Spyropoulos)

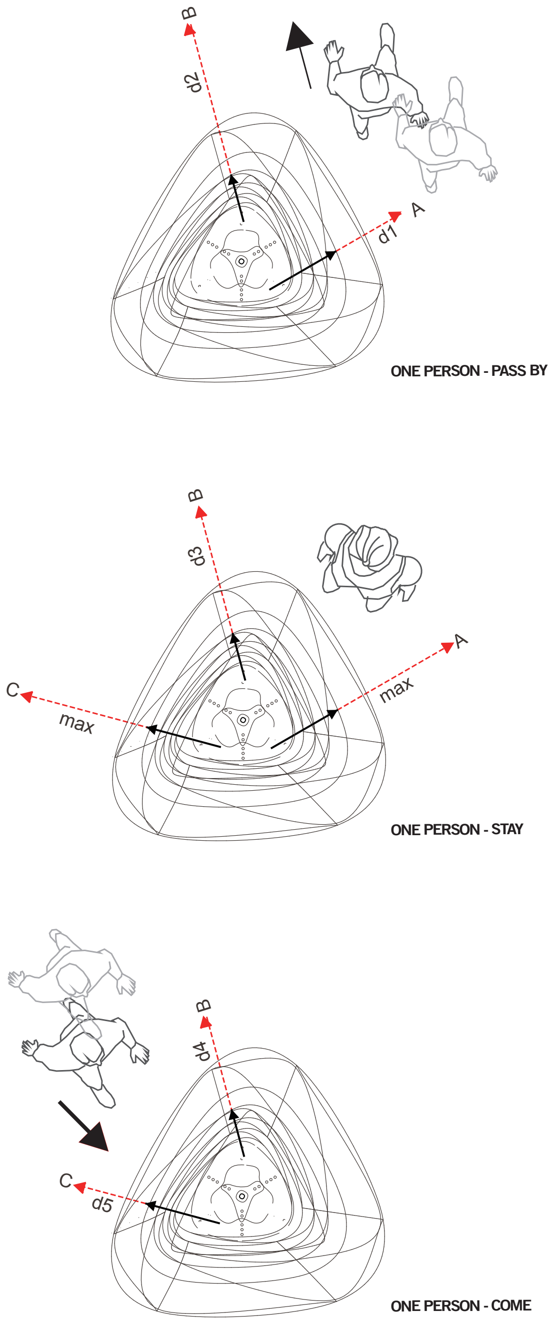
6 Please note that this text, written by the author of this PhD, was first published online at www.minimaforms.com (copyright by Theodore Spyropoulos)

7 Please note that this text, written by the author of this PhD, was first published online at www.minimaforms.com (copyright by Theodore Spyropoulos)

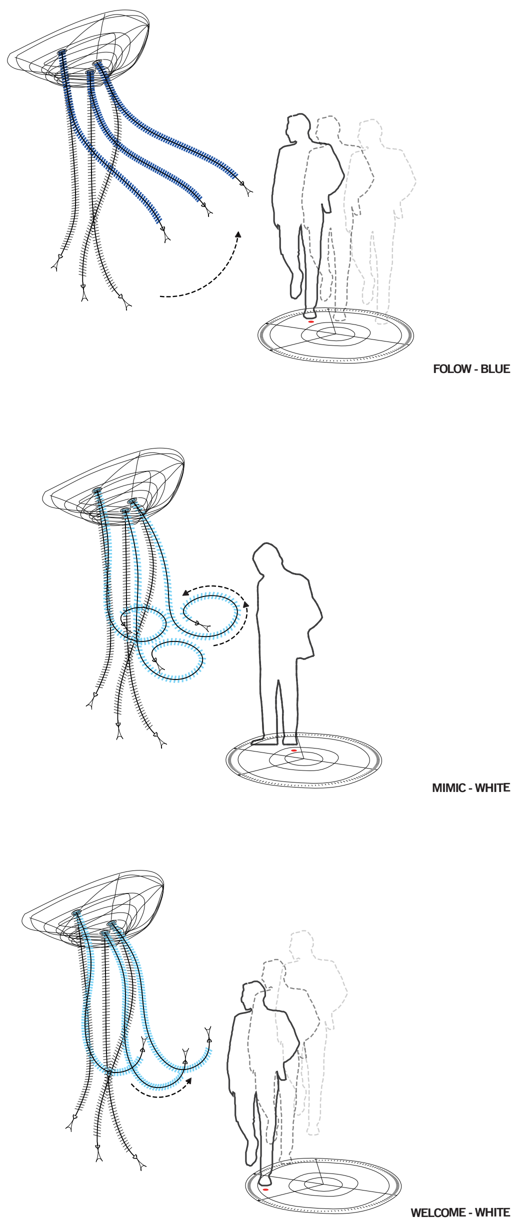
Position Calculation



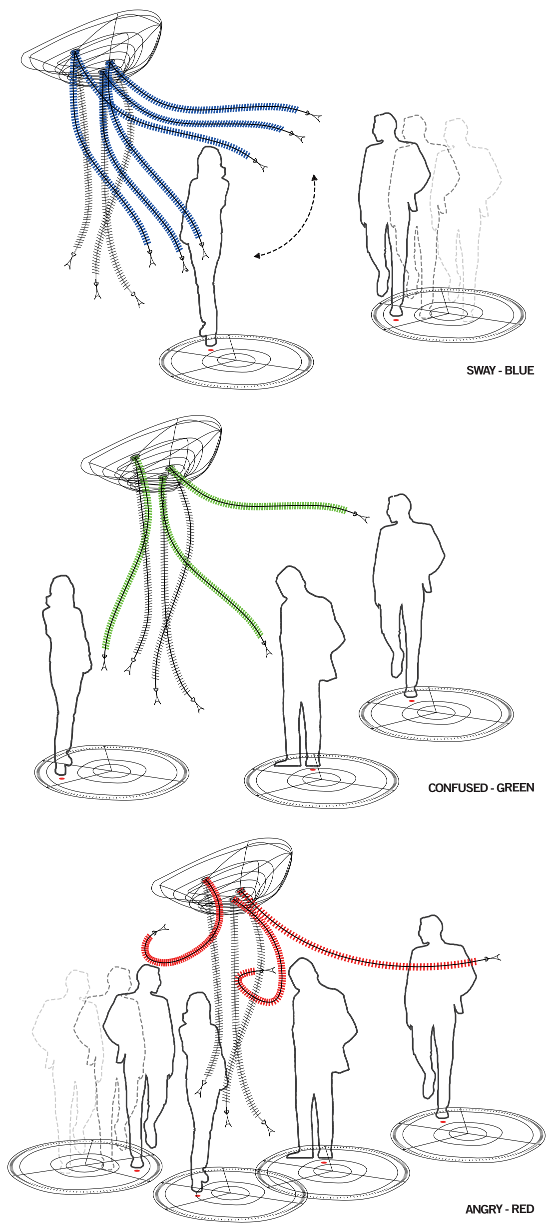
User Dependent Movement



One User Interaction



Multiple User Interaction



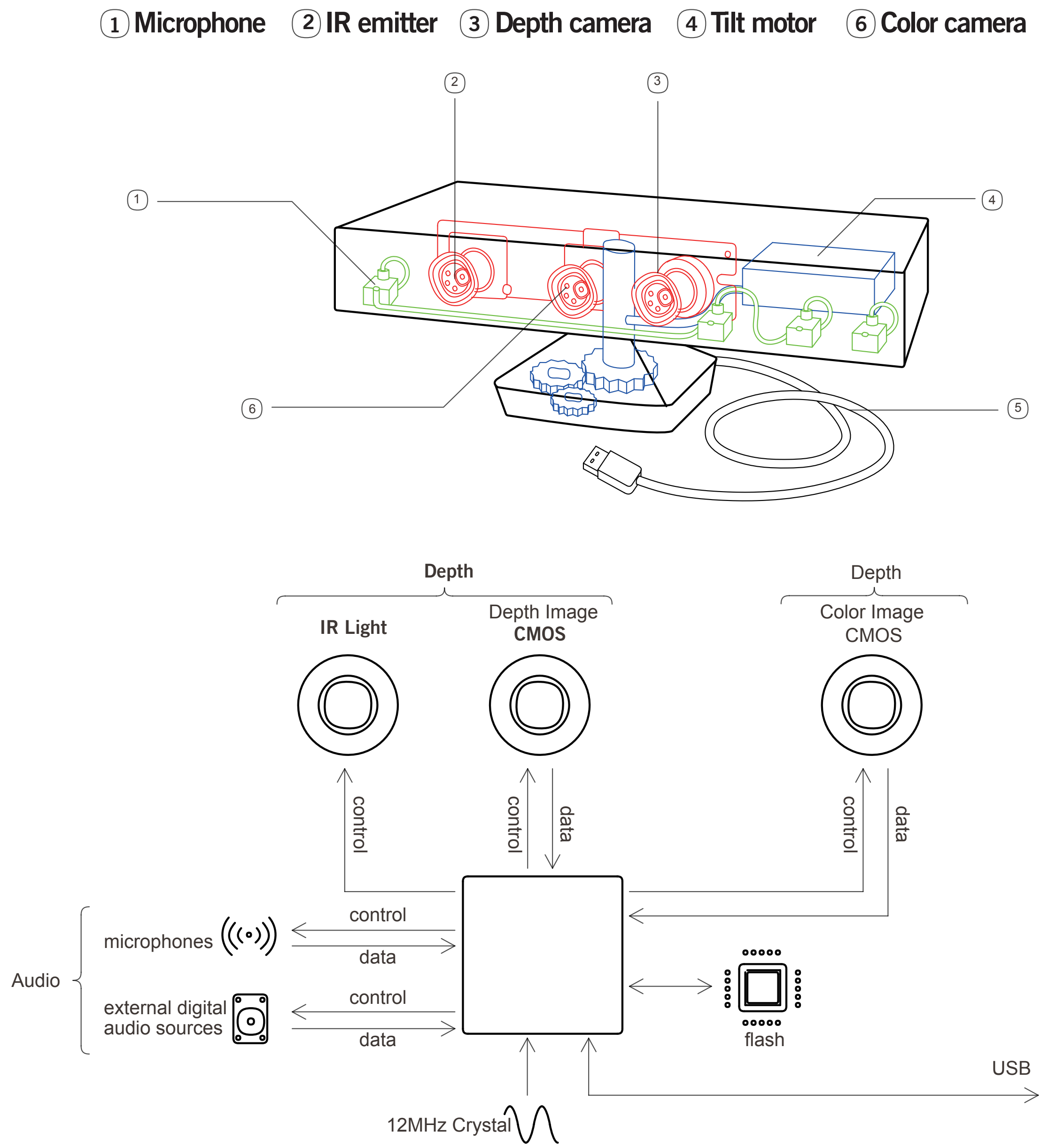


Figure 97: Vision Component Diagram

Inputs including location, touch, gesture based movements, multiuser interactions. Various outputs including sound, vibration, color, luminosity.

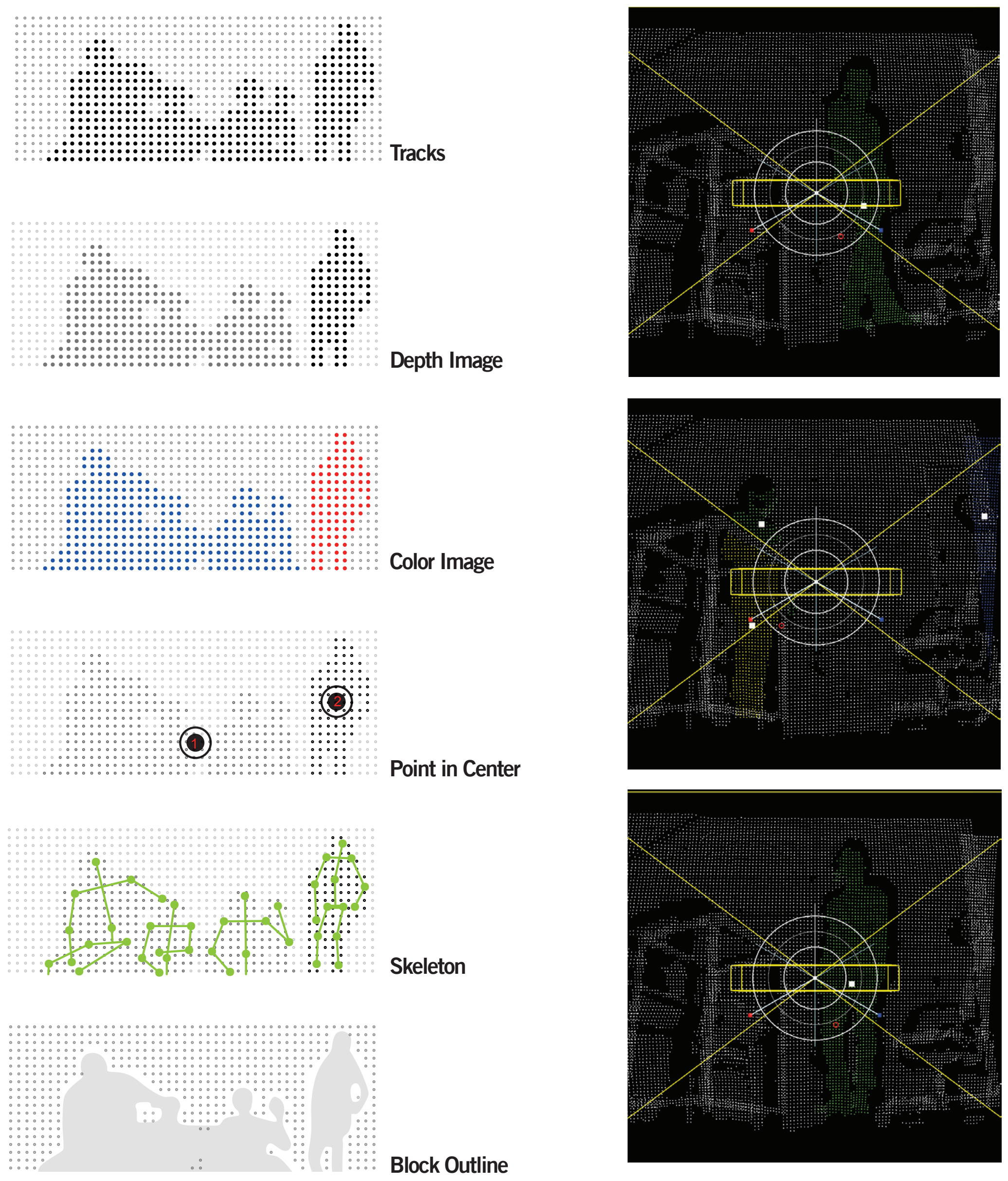


Figure 98: Vision Tracking System Diagram

Real-time data mapping

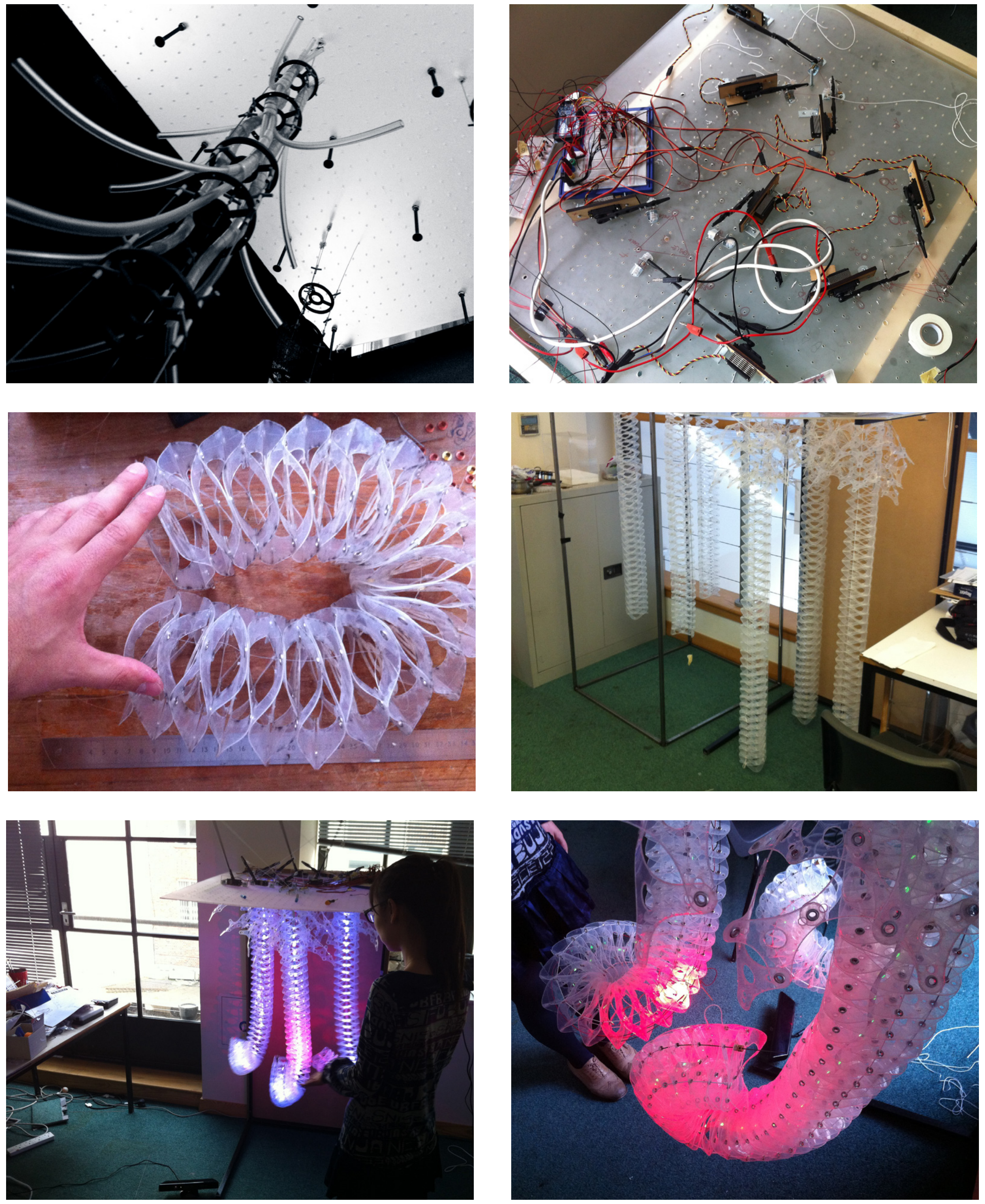


Figure 99: Petting Zoo Development

Pets are created to adapt and sense pattern that will form the basis of their respective behaviors.

PROTOTYPING

Design here explores communication between human and machine. Beyond computational drivers and control mechanisms of actuation the project conceptualises a form of interaction that goes beyond reactive engagements towards behaviour based models of design. Life-like characteristics have been pursued through gesture, posture and kinetic transformations. The project by necessity developed a series of prototypes that explored material behaviour, actuation and response. The physical prototype that addressed the operational criteria for quick response and fluid movements was as combination of material behaviour and a servo based actuation control. Material springiness in the polypropylene patterned and riveted sheets allowed for a quick release and controlled pliancy of movement. Actuation drivers included research into stepper motors, servos and other forms of soft actuation. Through testing and mocking up operational prototypes high torque servos where selected with custom carbon fibre rod attachments to choreograph complex movements and curling behaviours. Each appendage of the Petting Zoo had three servos with a total of nine servos per Pet. Choreographed control of three control points of each of the legs of the Pet allowed for complex curvature and movement to be choreographed between the servos movement as a direct response to interaction scenarios.

The installation included three Pets and suspended support structure that allowed the installation to be installed in black box gallery environment such as

Figure 100: Petting Zoo, Barbican Centre Exhibition Opening

The piece is an exploration in artificial intelligence and communication with our environment,

Figure 101: Petting Zoo, Barbican Centre Exhibition Opening

The piece is an exploration in artificial intelligence and communication with our environment, the FRAC Centre in Orleans, France or suspended from the main public atrium space of the Barbican Centre in London, England. The design of the work was considered to allow for consideration of varied types of spaces that the work could be considered for. The constructions of the Pets were also considered as close to a stand along product that allowed for third party care. This attention to detail has afforded the work to be toured by the Barbican International for five years since the *Digital Revolution* Exhibition.

A second aspect of the prototyping has been in the research and development of a vision system that would allow the Pets to observe participation and self regulate their behaviours accordingly. Implementing a Kinect camera as the primary scanning device the vision system looked to codify number of participants, account for their durational engagement, gestural mapping of all interactions between human and machine, and offer a information display that would communicate this to participants should they seek to understand further how the Pet behaved. A screen-based display was fitted in the main chassis of the Pet to allow participants to see themselves and their interactions codified and exhibited for accessibility. One of the challenges in developing the system that exhibits emotive features is to communicate to participants in unique and novel means. The vision system developed for the Pets was built at its core from two libraries that Microsoft released that used blob detection and a skeletal mode. Our software built on top of these libraries and constructed event triggering that allowed switching between these to modes. Blob detection is primarily used to distinguish humans from scenes. Skeletal mode is a kinematic model that locates the joints of human bodies through point and line delineation. In our software development the blob detection is the primary mode of interaction as we identify generalise human engagement and colour codify all actors within a scene. This allows the pets to be able to cope with large crowds and exhibit behaviours that are responsive in kind. As the pet becomes more intimate with a participant and the participant engage close with the pet. The systems switches from blob detection to skeletal mode to focus on hand gesture and in particular upper body movements.

Figure 102: Interacting with Pets

In the form of suspended robotic arms 'Petting Zoo' is a generative robotic installation populated by inquisitive and artificially intelligent creatures, which respond to human engagement.

Figure 103: Interacting with Pets

Using a bendy sensor, the instrument would capture an image and archive this as part of the collective databank. Below, a screen displays the captured image.

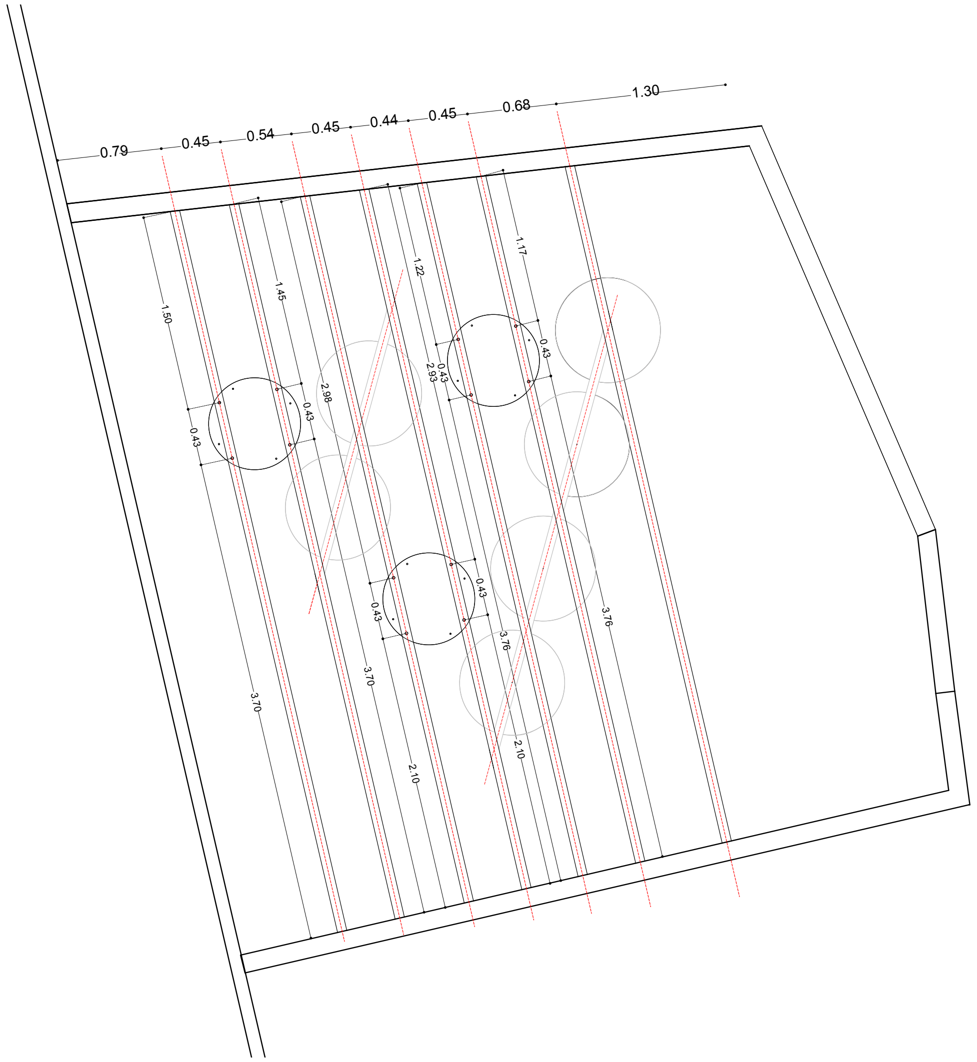
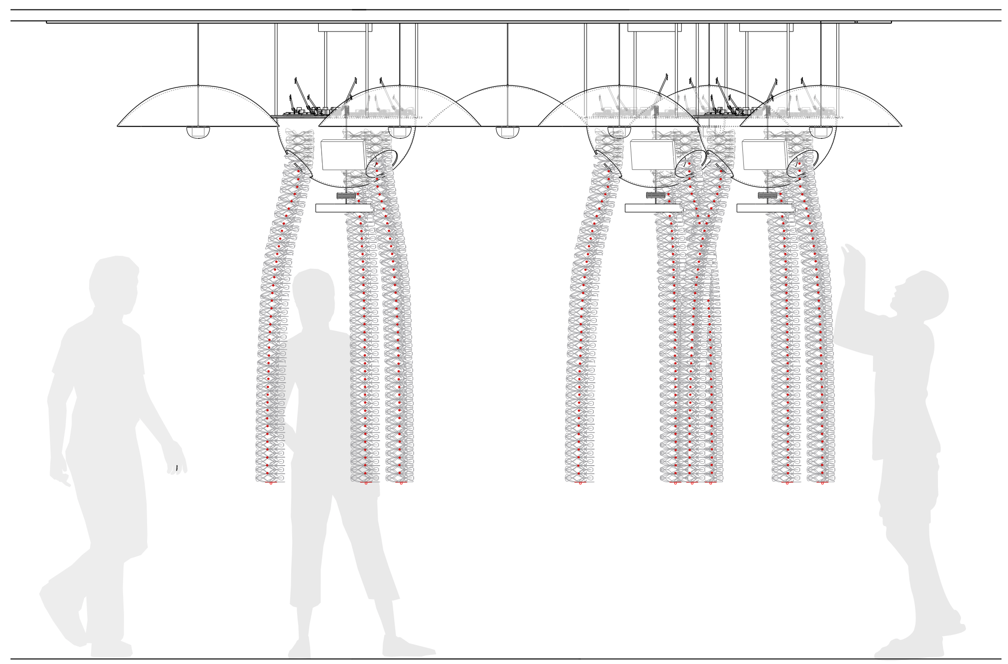


Figure 104: Organizational Plan, Frac Centre

Using a real-time camera-tracking system that can locate people and detect gesture and activity each pet has the capacity to process data so that they can learn and explore different behaviours by interacting with the public and each other.



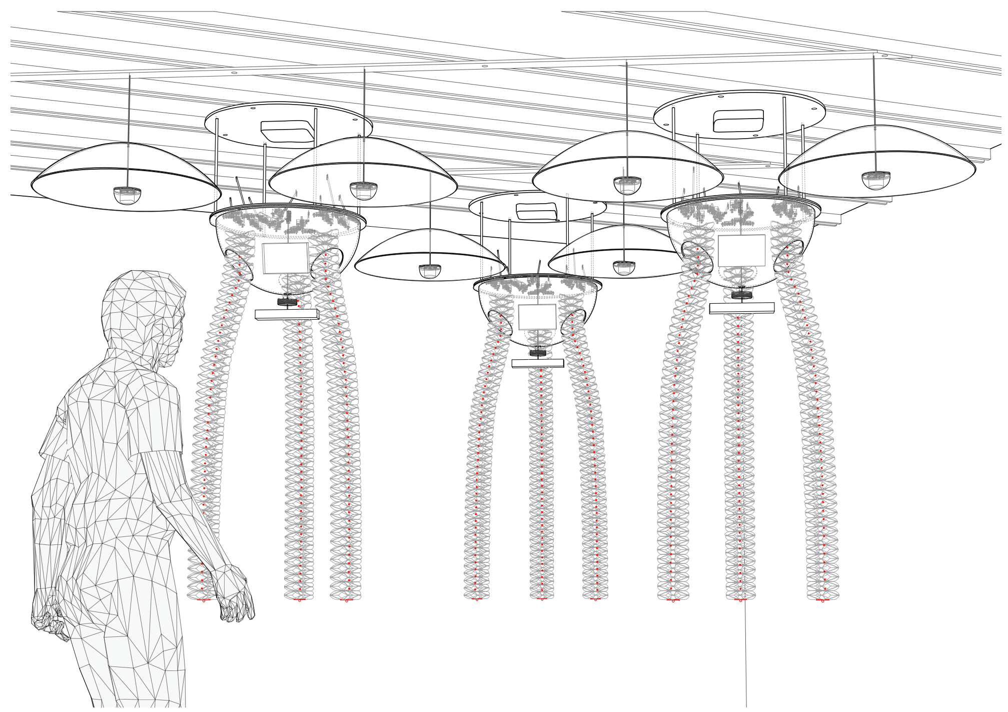


Figure 105: Petting Zoo, Barbican Centre

Over the course of the exhibition these personalities will be developed through human interaction enabling intimate and immediate exchanges that are playful, emotive and evolving.

Figure 106: Young Participant Interacting with Pets

Using a bendy sensor, the instrument would capture an image and archive this as part of the collective databank. Below, a screen displays the captured image.

OBSERVATION

Petting Zoo embraces a desire to explore design through behaviour. Operating within a *Human Machine* framework, the research examines intelligence as a product of interaction. Intelligence is not embodied in a thing itself but in the interaction between things. This evolving relationship is argued to have the capacity to construct novelty and stimulate further interaction. This reminds us of the Paskian concept of novelty fostering pursuits of control. Cybernetic sculptor Edward Ihnatowicz whose work is a key reference recognised the importance of behaviour through works that he developed such as the *Senster* and *SAM*. He understood that the appearance of the machine was limited in communication and only through animation and atmosphere that new possibilities to elicit life-like qualities could manifest. It is this projective life-like quality that promotes the human tendencies that unlock curiosity and wonder enriching participants experience. Behaviour is the enabling attribute that this thesis highlights as the means in which to explore emotive and human interactions through design.

Petting Zoo through its use of the kinetics, illumination and sound offers a diverse set of variables to explore behaviour. Having installed the work now in five public institutions around the world it has reinforced the need for designers to design systems that are prototypical in nature and have the capacity to be hyper contextual through interaction. Adaptation through design allows for systemic thinking to be considerate of behavioural methods and practice. Petting Zoo is a live experiment. Through interaction the Pets gain access to human engagement.

This information is graphed in relation to its respective behavioural response. Over time and in response to habit the Pets could be argued to develop a form of “personality”. As orientation and environmental features of installations cause diverse interaction scenarios for each Pet, over time they form unique capacity to exhibit varied behaviours. The personalities are evolved through a process of self-observation of the system. These observations are apparent to the authors and to hosting institutions that engage with the Pets on weekly if not a daily exchange. This capacity to see difference between the Pets and for this to be meaningfully understood is very compelling. Unlike auto correction as found in speech to text editors and other machine learning strategies what is at stake here is simple but yet profound. How can we design systems that evolve with us? How can this co-evolution offer us ways of operating through the world where our human machine frameworks afford a greater sensitivity to what we understand as our primal states? Through the machine we may find humanity.

Figure 107: Petting Zoo Opening Night Barbican Centre, London

Pets interact and stimulate participation with users through the use of animate behaviors communicated through kinesis, sound and illumination.

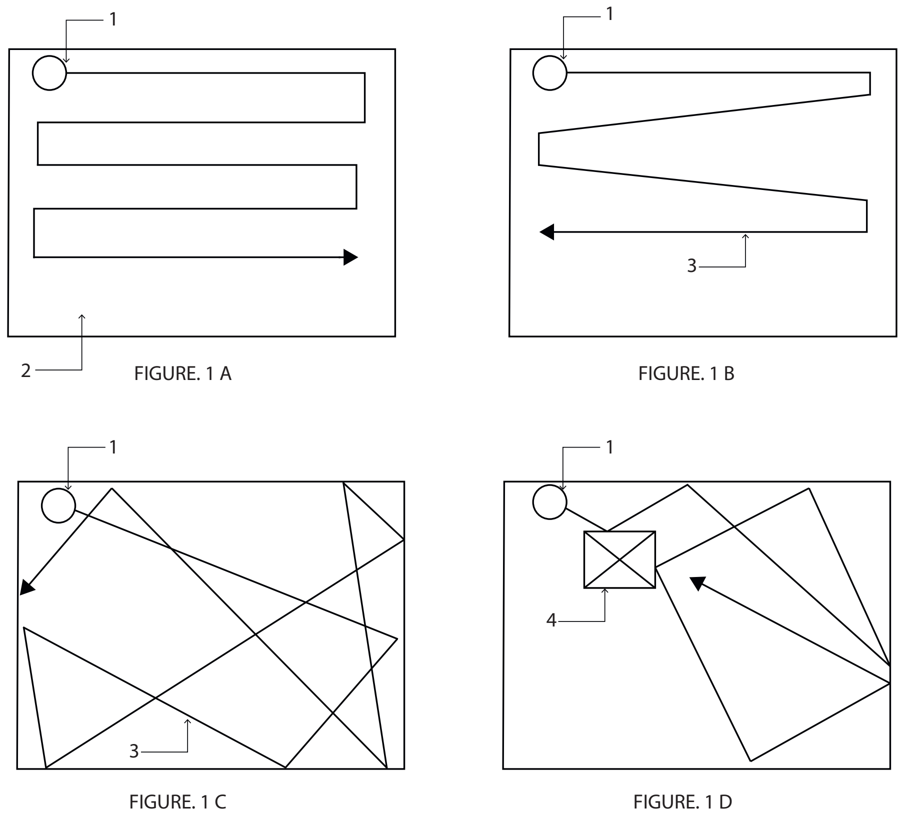


Figure 108 : Roomba : Autonomous Robotic Vacuum Cleaner

Integrated with VSLAM(Vision Simultaneous Localization and Mapping) ,gives Roomba a more effective navigation and mapping capability.
1 Roomba 2 Space 3 Mapping lines 4 Obstacle

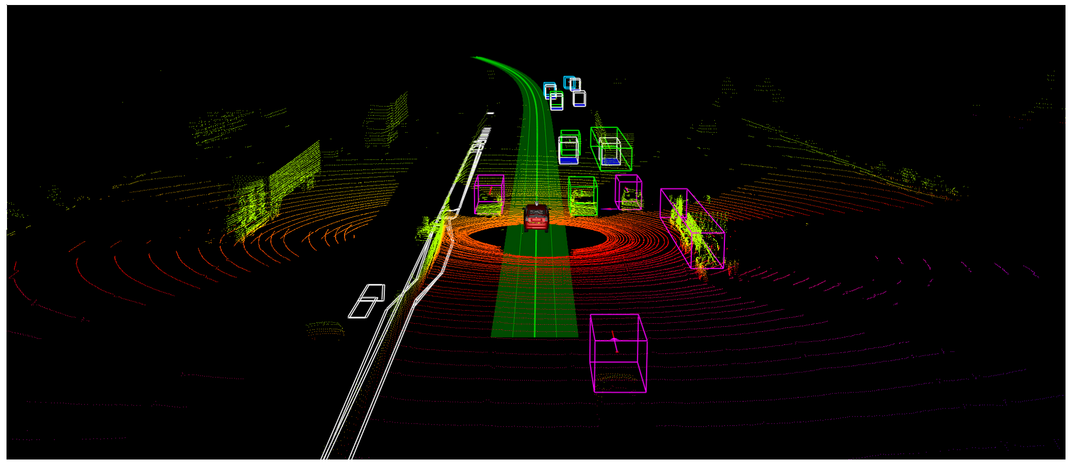


Figure 109: Self-Driven Vehicle: Car View Trajectory

Localization strategies are explored with the help of laser range finder mounted in the roof.

MACHINE MACHINE

The third and concluding chapter explores non-human frameworks as machine-to-machine robotic ecologies. The first chapter in this thesis *Human Human* examined interfacing that focused on human enabling and participation in an attempt to create a framework for public engagement. Human Human interaction created a platform for shared human expression and experience. In the second chapter *Human Machine* our emotive and behavioral co-habitation of humans and machines was examined. This chapter focused on the life-like tendencies that afford a rich interplay between our relationships with things. As the first two chapters focused on human relations with either other humans / crowds or with machines, this concluding chapter *Machine Machine* looks towards constructing a systemic design framework to explore an autonomous architecture. The aim is to create a system with design agency that has the capacity to be mobile, to be self-aware, self-assemble and self-structure. The architecture argued for here has no blueprint or master plan but rather is goal oriented, self-organized, a high population distributed system of interacting agents. Architecture here has no final state but is continually in a process of formation. Beyond form this architecture can continuously evolve by introducing new goals for itself through collaborative interaction. The model of interaction here is local and distributed. Unit-to-unit communication evolves higher ordering goals in the creation of organizations enabling new behaviors. Machine-to-Machine interaction evolves solution spaces to address a given task. The research developed in this chapter has been developed at Architectural Association's Design Research Laboratory which I

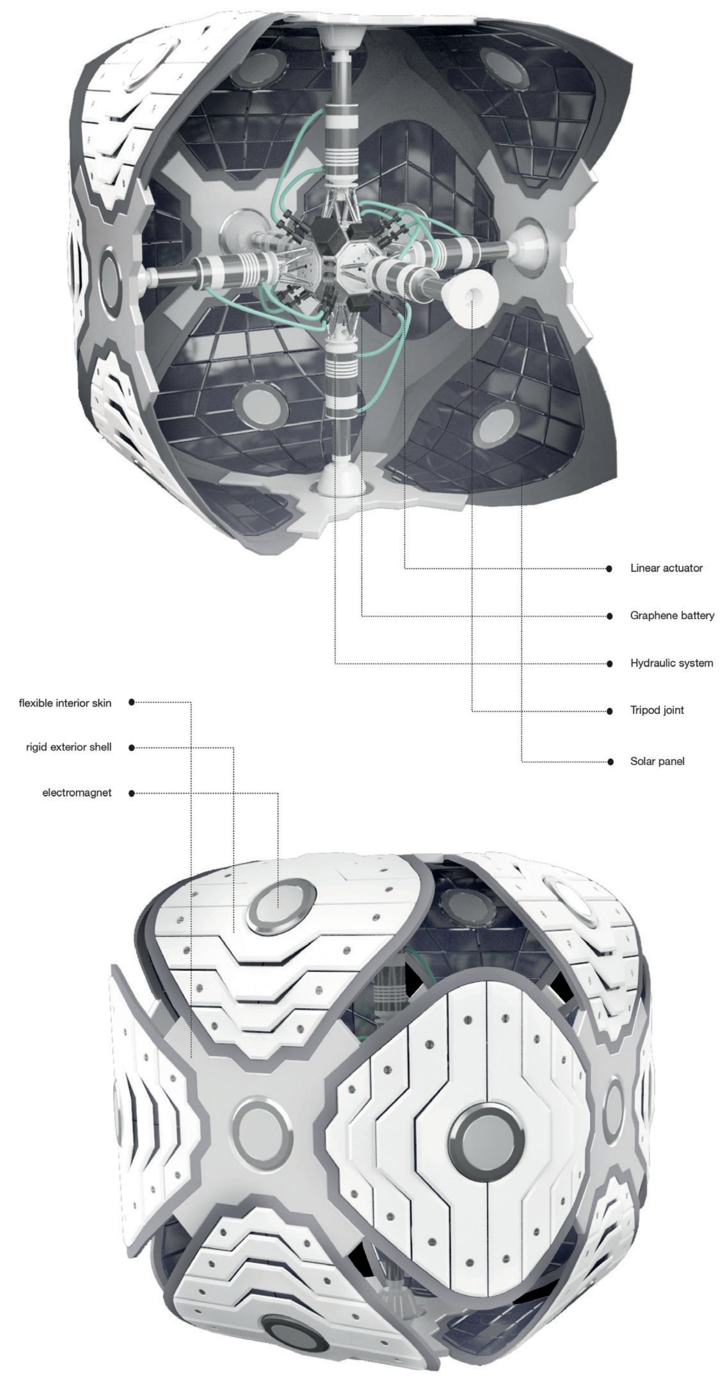


Figure 110 : Self Structuring

Exploration of different building strategies,like the shortest path, collaborative motion to understand growth patterns and energy efficiency. AADRL Spyropoulos Design Lab, Project HyperCell, Architectural Association Design Research Laboratory, London, 2015

direct and where I have run the Spyropoulos Design Lab for the last twelve years. The emphasis has been exploring prototypical design systems with the capacity to be mobile and self-structure. These systems are generative and construct space and structures through genetic signaling for example in stigmergic communication.

Agent to agent interaction within these adaptive ecologies are evolutionary and engage a world of behavioral practice that move beyond top down and bottom up computational logic. These ecologies consist of families of high population agents that construct fitness criteria by distributing genetic algorithmic processes that inform their morphological and neurological control systems. This process within a digital breeding and competition environment can be illustrated through the seminal work of Karl Sims in his papers on the subject written in the mid nineties such as *Evolving Virtual Creatures*[1] and *Evolving 3D Morphology and Behavior by Competition*[2]. Creatures within this competitive environment evolve through iterative and incremental evolution. The body plan is a choreographed correlation that through goal orientation can exhibit features such as mobility. Precedence within this research paradigm in modular robotics and deployable systems can be found in the research most notably of Hod Lipson and his Creative Machines Lab at Columbia University (formerly at Cornell University), The Wyss Institute for Biologically Inspired Engineering, and Dr. Raffaello D'Andrea from ETH's Institute for Dynamic Systems and Control.

Unit-to-Unit Interaction

Units in this research are the smallest incremental building blocks within the system. They constitute simplified features that consider mobility, basic sensing,

1 K.Sims, Computer Graphics (Siggraph '94 Proceedings), July 1994, pp.15-22.

2 K.Sims, Artificial Life IV Proceedings, ed.by Brooks & Maes, MIT Press, 1994, pp.28-39.

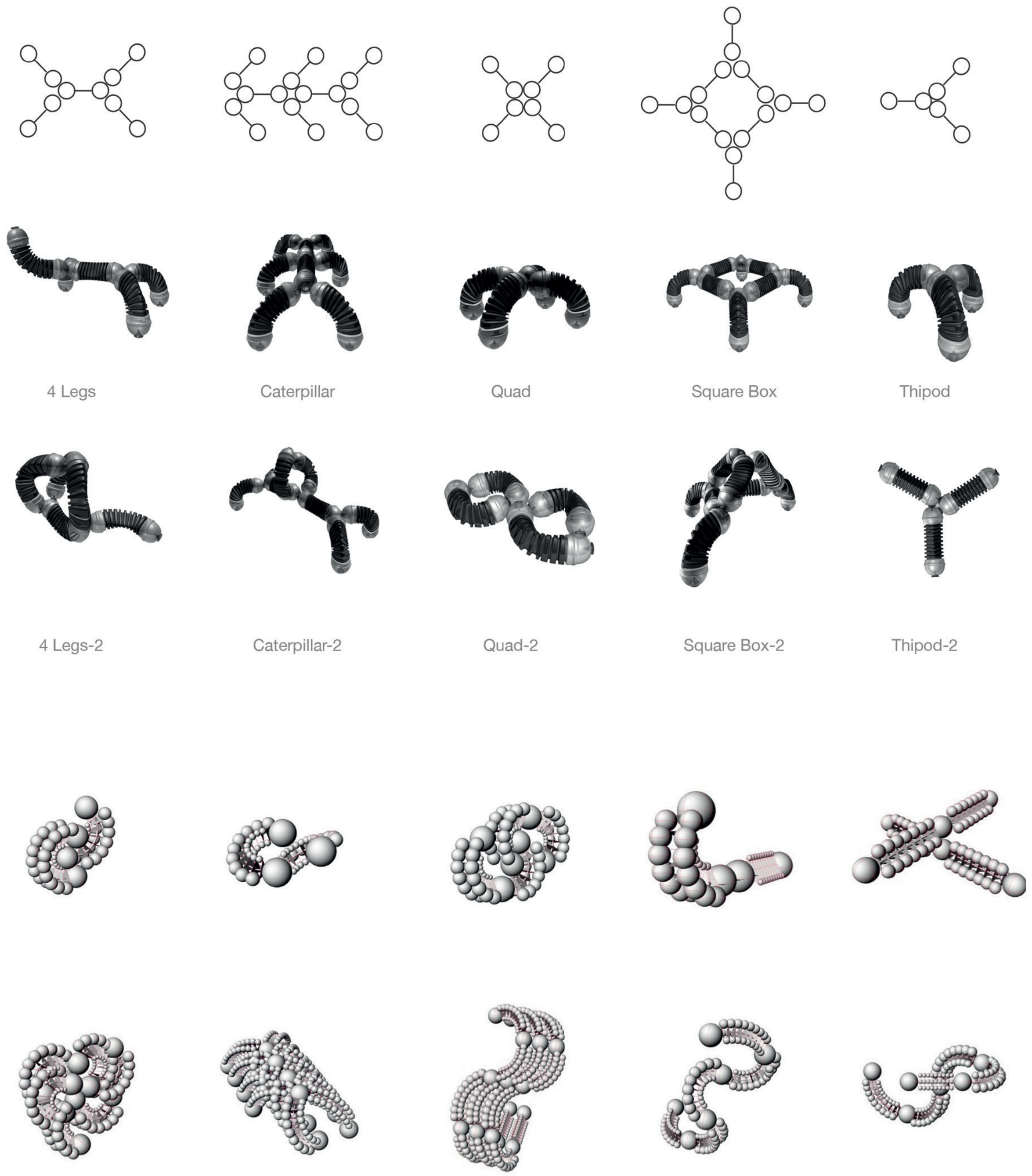


Figure 111: Body plan Taxonomies

Different type of body plans emerging from a primitive unit strategy, Body plans showcase different capacities of mobility and self structuring. AADRL Spyropoulos Design Lab, Project OWO, Architectural Association Design Research Laboratory, London, 2015

proximity, energy creation and actuation for self-structuring. All the projects explored within this research examine the role of the singular within a collective. Here limits in the individual unit can be compensated by collaborative practices of assembly. Assembly here is task specific and can assemble and dissemble as needed to address the goal at hand. Taxonomies of small-scale organizations allow for more complex creatures to exhibit high ordered behaviors. This bodybuilding allows for species to emerge and evolve creating new behavioral attributes that also assist in locally managing population coordination. The approach hold true in higher populations allows in principal recursive strategies of high-resolution design systems to be understood.

Geometric vs. Soft

Units within this research have over the last four years explored a series of actuation and space generating strategies. First generation prototypes looked towards geometrical finite states that allowed for packing strategies that were explicit face-to-face connection. This explicit computational goal generation allowed for a direct correlation between generative logics and prototypical unit distribution. Hard plate based geometries were coupled with an actuation system that was mechanical in piston based or pneumatic spring based systems. These approaches allowed for control systems that were understood computationally allowing for voxelization strategies to be setout. Two dominant organizational logics came out of this early research. One of the most compelling was a unit design strategies that maintained simple cubic to spherical shape transformation through inflation. The unit named *Hypercell* was a simple in actuation and shape correlation to mode of behavior allowing for complexity to emerge through high population combination. The unit because of its simplicity by passed the need to organize body plans. The challenge was the individualized control that would be need for the quarter of a million units that were deployed within the scenario. The

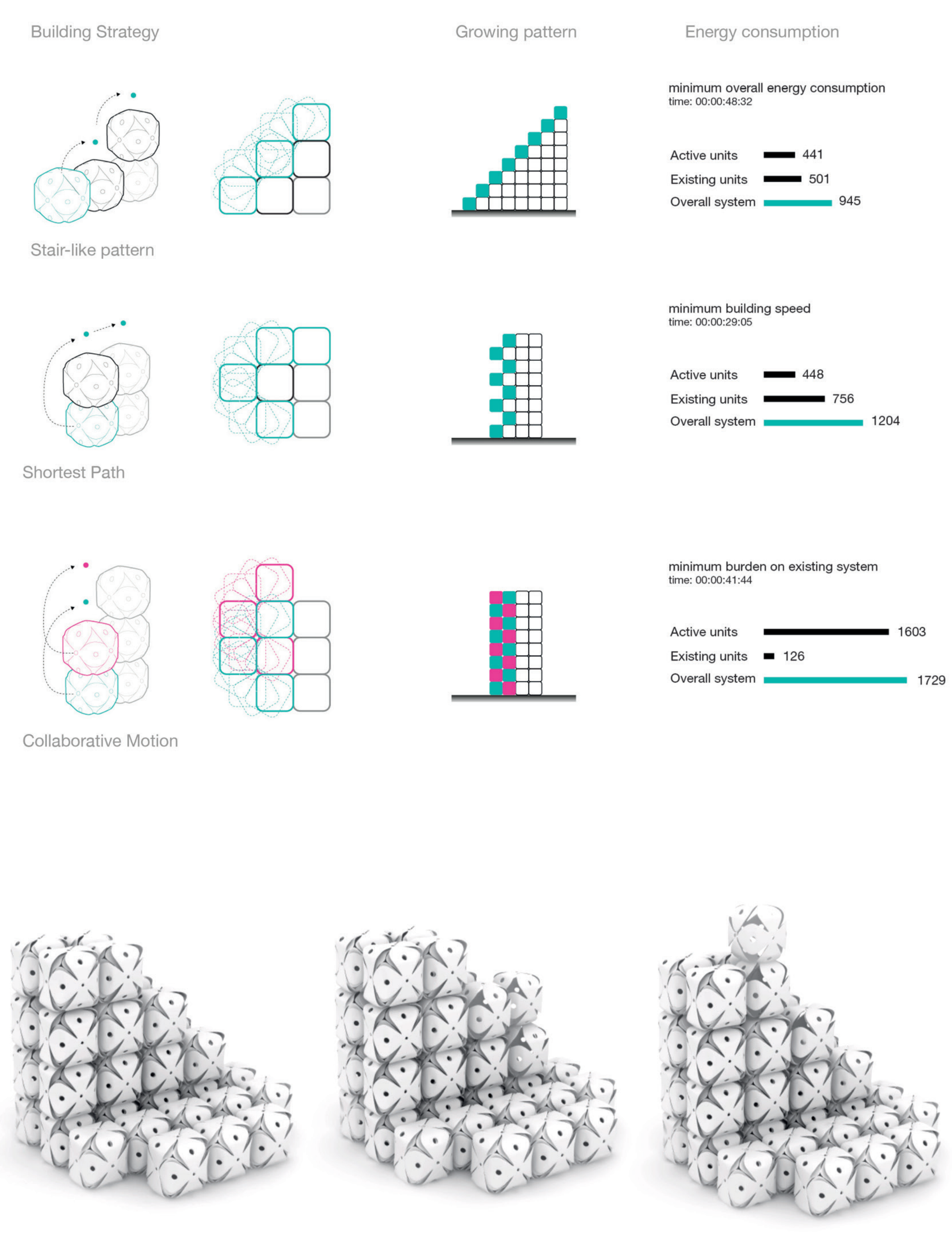


Figure 112: Self-Structuring

Exploration of different building strategies, like the shortest path, collaborative motion to understand growth patterns and energy efficiency. AADRL Spyropoulos Design Lab, Project HyperCell, Architectural Association Design Research Laboratory, London, 2015

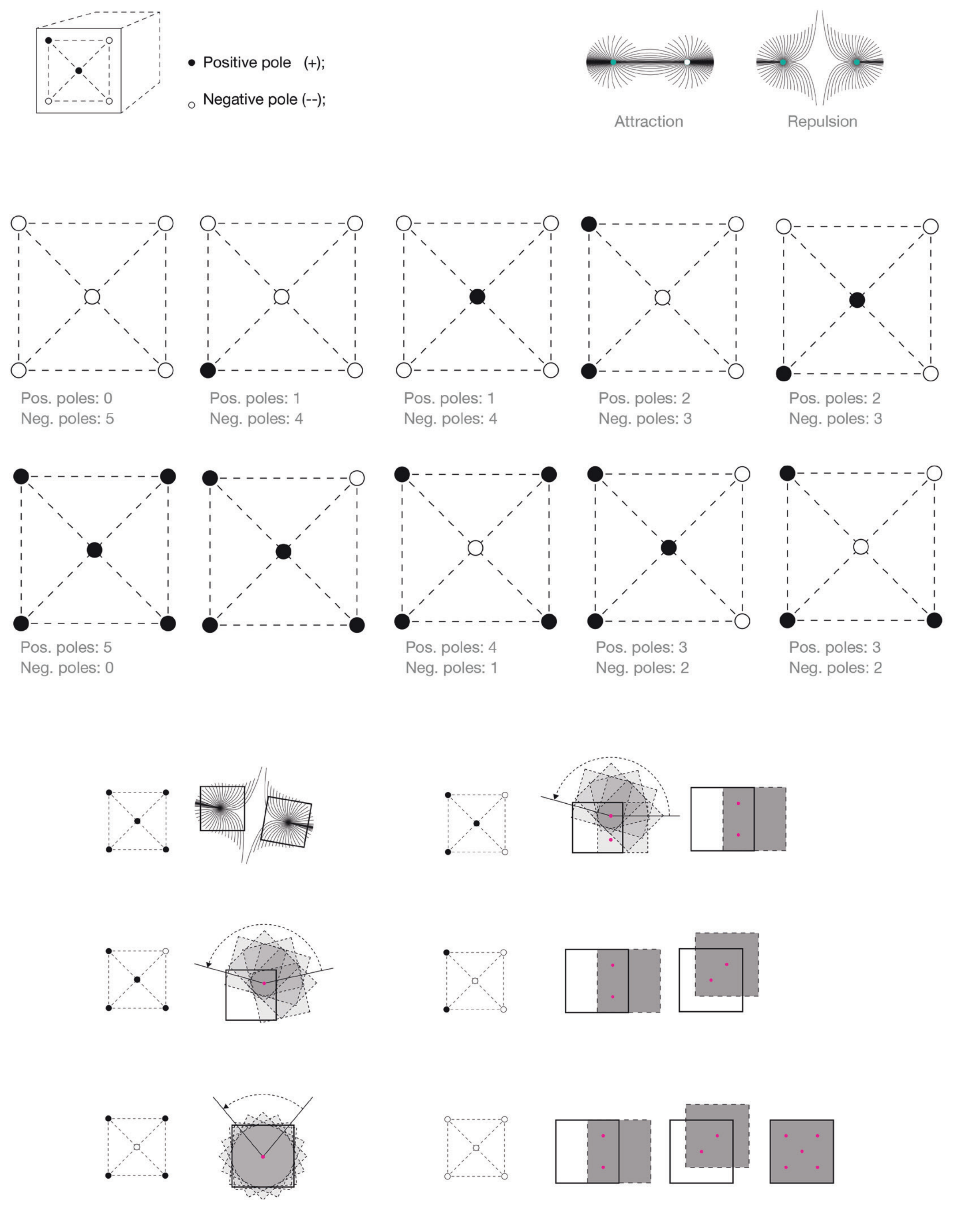


Figure 113: Magnetic Pattern

Shifting of magnetic polarity on the connection magnets helping in a more controlled and precise assembly. AADRL Spyropoulos Design Lab, Project HyperCell, Architectural Association Design Research Laboratory, London, 2015

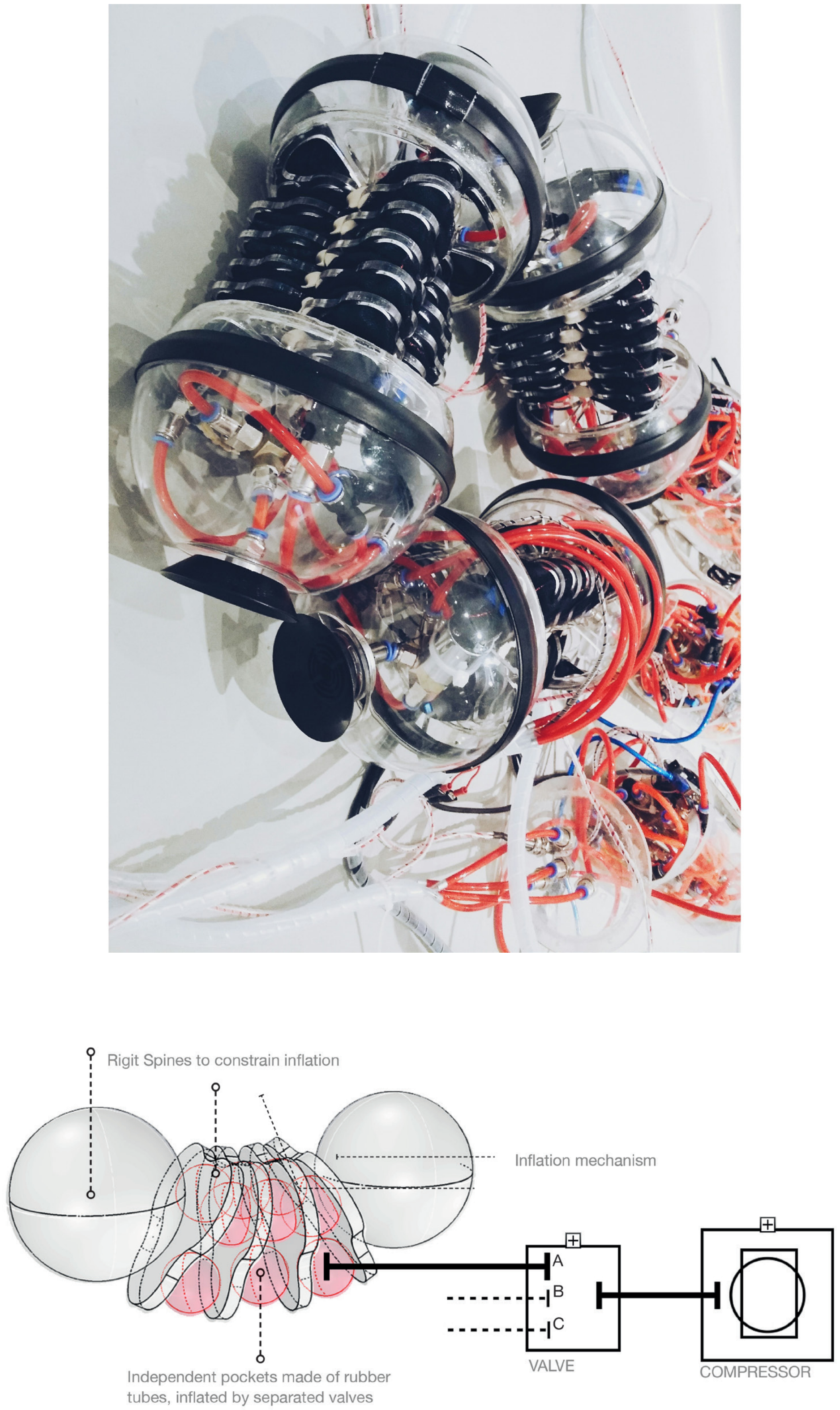


Figure 114: Prototyping Diagram

MACHINE MACHINE

second organizational strategies was not discrete in it packing like *Hypercell's* voxel-based system but rather were based on particle spring based setups. This strategy exhibited challenges for two state examinations but in transitional states exhibited the most behavioral rich and complex behaviors. OWO was a unit prototype that was developed based on pneumatic spring. As an individual unit it could role and curl. Over all very limited in its mobility and self-structuring capacity. Coupled with two other components the behavior and capacity radically transformed, as now this unit assembly had a tripod configuration and could walk and negotiate terrain such as curbs or stairs. This body plans transformation through unit-to-unit organizations afforded the possibility for varied and diverse taxonomy of creatures. The creature could evolve more legs or change to a more segmented body… as in the virtual world of Karl Sims we had managed a physical manifestation.

Primary Modes: Mobility vs. Self Structuring

Machine Machine strategies within this research could be discussed through two primary modes that influenced the goal seeking behaviors and the organization. Mobility of individual units was primary. The first is the ability for units to move within a range and communicate to other units. Also organization patterns worked with in range and around seeding points that organized a convergence of units to be in a position to switch modes. The second mode is from the informal mobility, which is 2d in organization to communicate population distribution that is 3d goal orientation. As every unit is a potential smart brick in the system, iterative forecasting strategies are real-time processed with possible solution spaces. The system is not dependent on secondary scaffolding it can erect temporary supports to assist the creation of the desired space. As there are a multitude of solution spaces that can fit the fitness criteria factors such as energy and time become dominant factors.

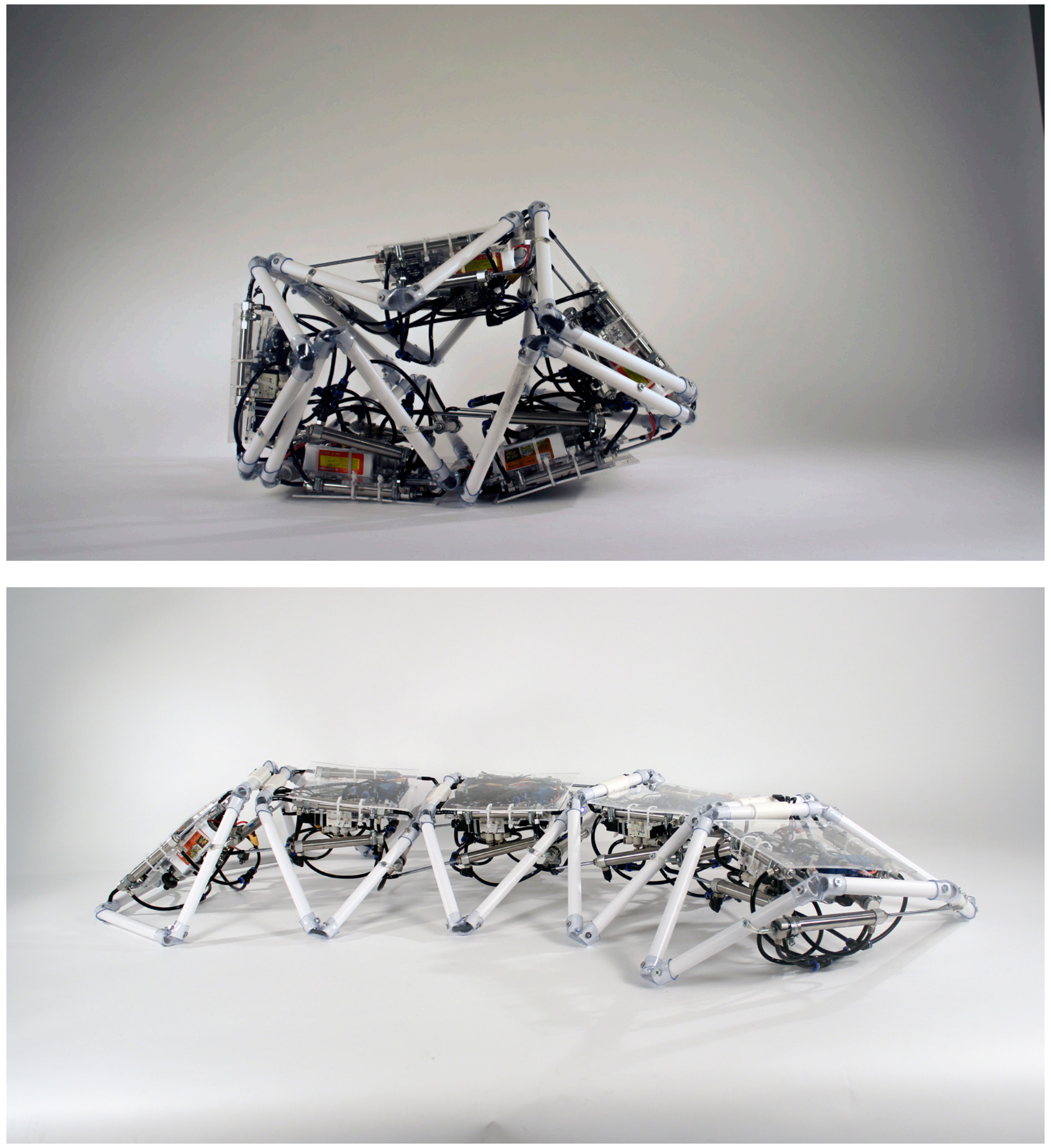


Figure 115: Prototype Study

Exploring mobility through sequenced actuation pattern, helping in triggering rolling and linear motion. AADRL Spyropoulos Design Lab, Project Delta , Architectural Association Design Research Laboratory, London, 2016

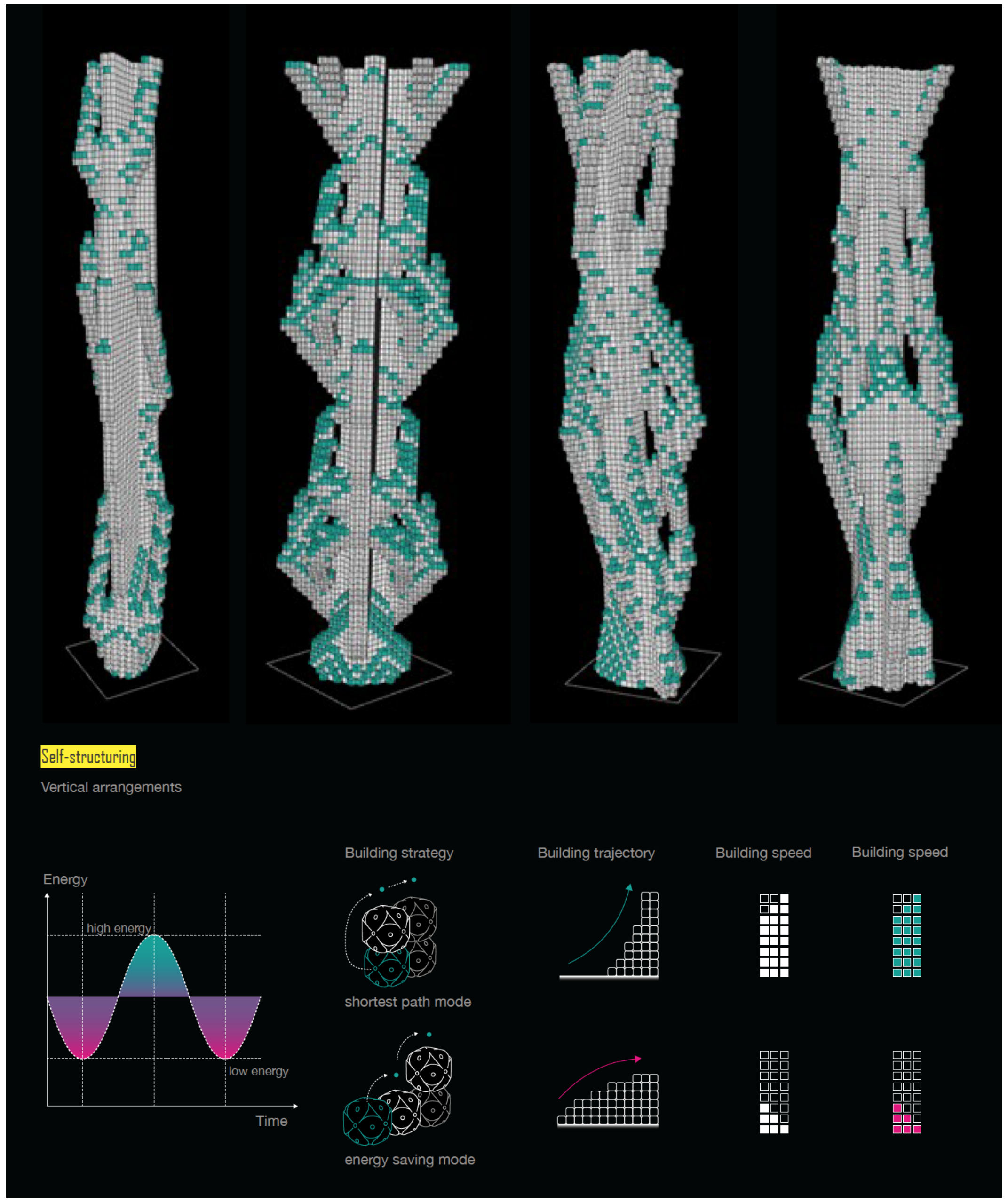


Figure 116: Self Structuring

Simulating vertical arrangement strategies, with the use of a voxel based programming .It helps in analysing real time self structuring capability of the unit. AADRL Spyropoulos Design Lab, Project Hypercell , Architectural Association Design Research Laboratory, London, 2015

Figure 117 Hod Lipson : Creative Machine Lab (Columbia University)

In conversation with Hod Lipson at Creative Machine Lab.

Self-aware / Self-assembled / Self-structured

All the rules of architecture within this system are challenged as the speculation suggest that there is no finite state. The possibilities is that this architecture would be migratory, have the capacity to be on demand and get bored and propose architectures that will challenge. The aim is to develop the concept for an autonomous decision making system that co-evolves with us. An architecture that can radically transform every day or pick up and move should there be a flood or political upheaval. It is an architecture that is not tied to existing infrastructure with the same dependency as we have come to know. Self-awareness allows for agency in the unitary stage and through combinatorial exchanges principled 3d dimensional strategies manifest. This is architecture is real-time, conversational and emotive. Beyond physical mobility these creature like aggregates have the capacity to appear life-like and playful. The discourse around this *Machine Machine* research shares in the scope and motivation to visions proposed by Cedric Price's seminal project the Fun Palace. Price when discussing Fun Palace stated, "The varied and ever-changing activities will determine the form of the site. To enclose these activities the anti-building must have equal flexibility. Thus the prime motivation of the area is caused by people and their activities and the resultant form is continually dependent on them."[3] Like *Fun Palace* projects such as *Generator* developed with John and Julia Frazer argued for a

3 Mathews, S. (2007a) From Agit Prop to Free Space: The Architecture of Cedric Price. First edition. London: Black Dog Publishing. pg. 73

cybernetic approach to address latency and change. Architecture was considered as an operational infrastructure to organize and actively contribute. How could architecture radically reconfigure? Who would control this these systems? In considering the research developed within this Machine Machine chapter, the attempt has been to ask if an architecture could exhibit its own behavior, could this behavirour have meaningful influence in how we engage space, control it or allow ourselves the experience to evolve with our spaces. This research is motivated with the idea that organizational strategies could be considered as something that evolves with us. Speculating on what an architecture that could self-organize, understand own body plan and evolve goals would suggest an active dialogue and exchange with architecture that would life-like in kind. What would we ask of this architecture? What would it offer?

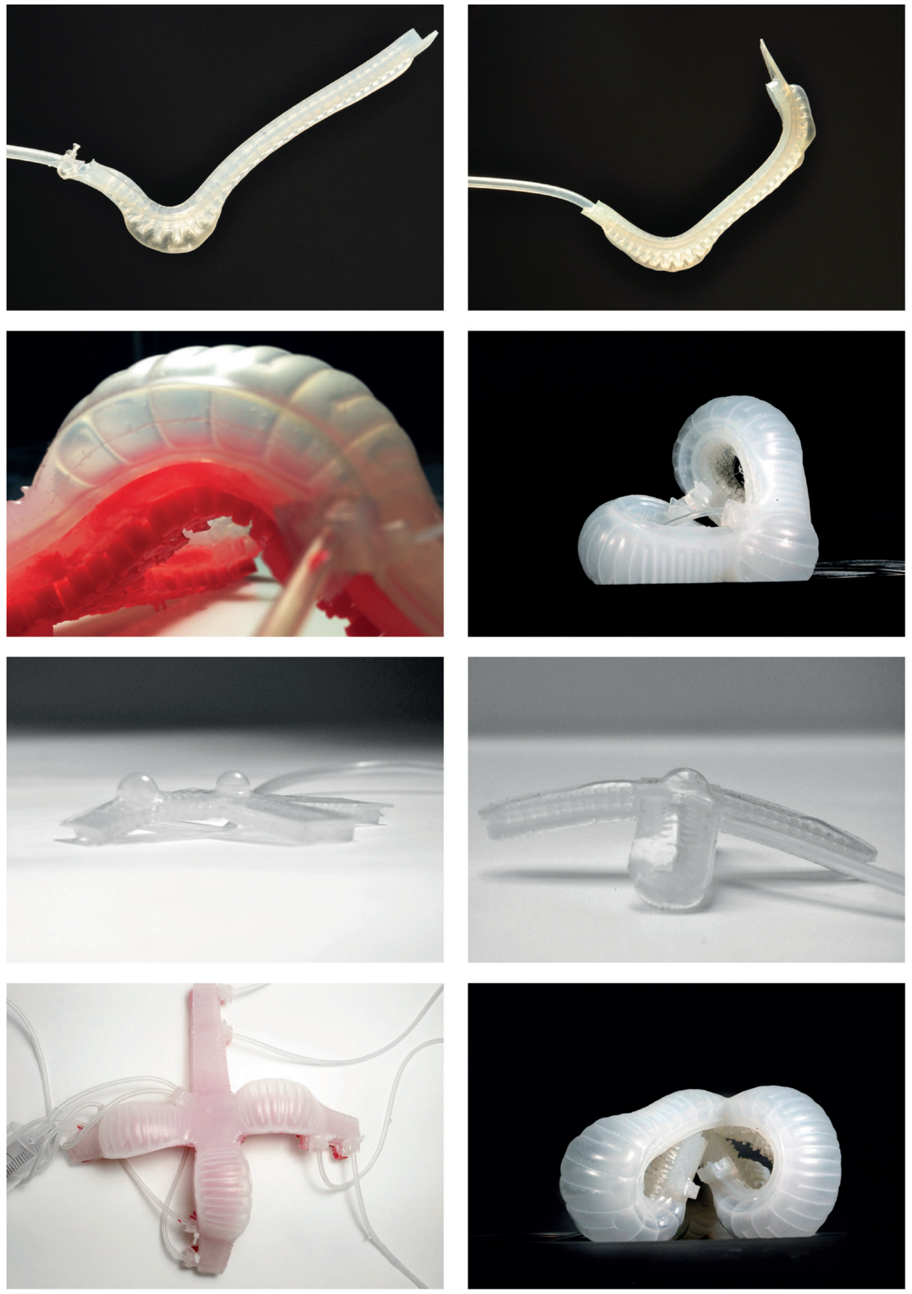


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Figure 118: Soft Robotics

Evaluating Movement patterns in different body taxonomies. AADRL Spyropoulos Design Lab, Project XO, Architectural Association Design Research Laboratory, London, 2016

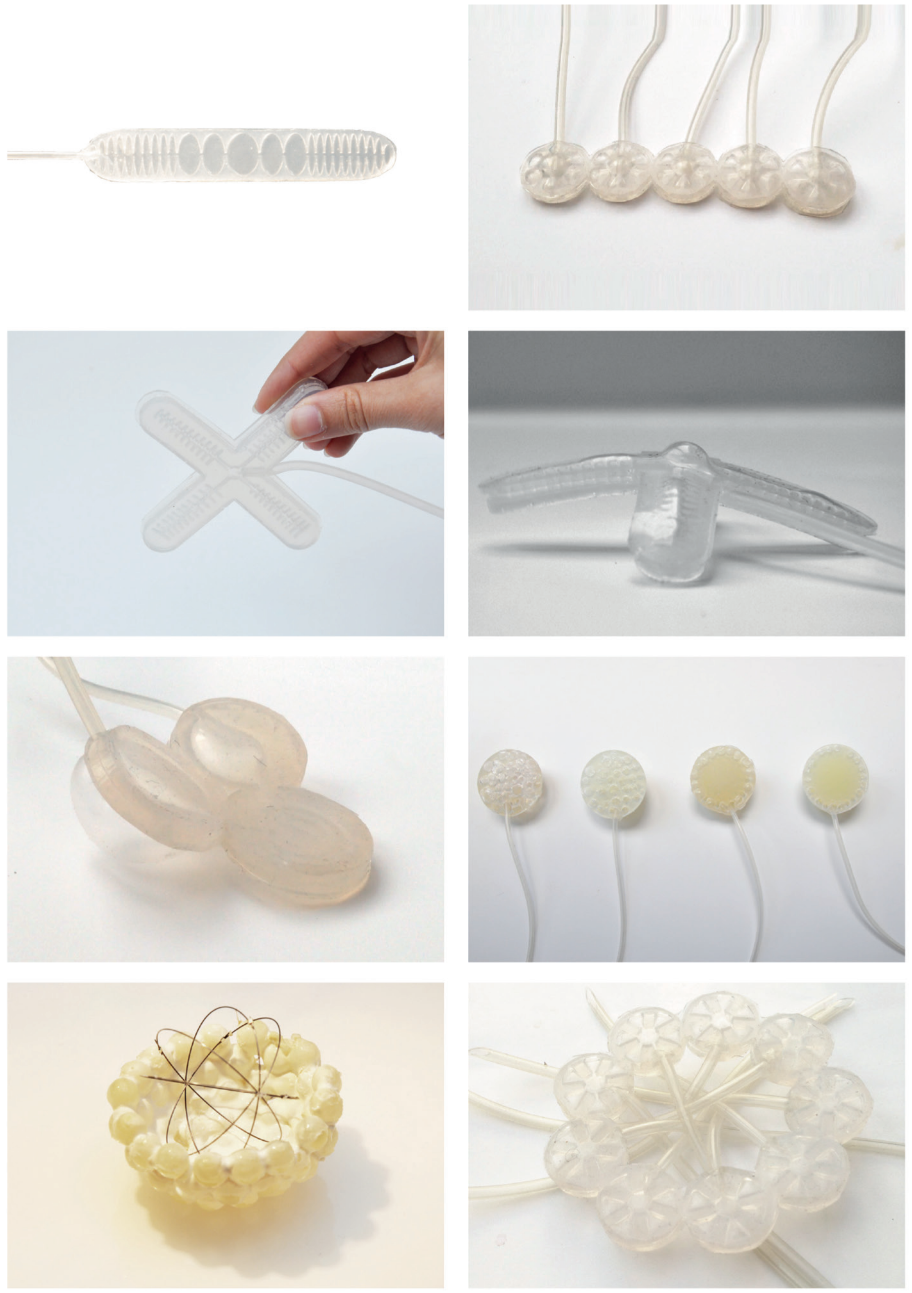
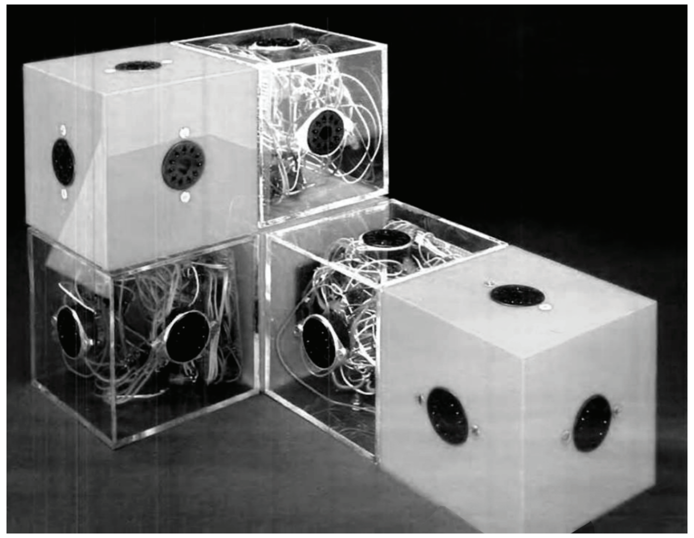
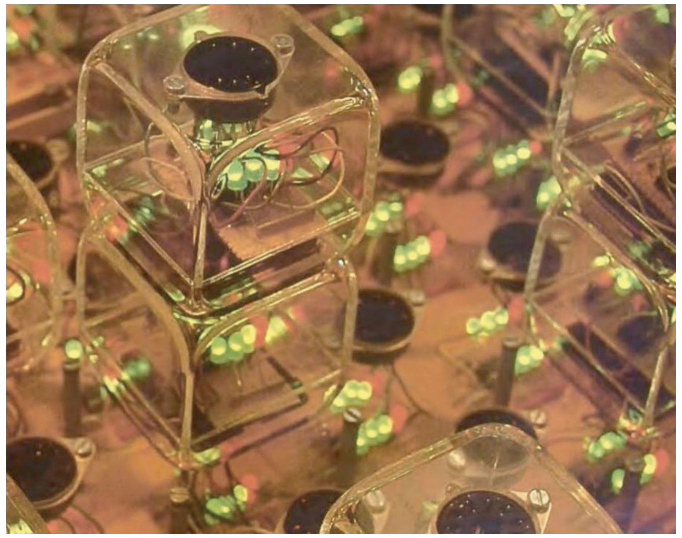


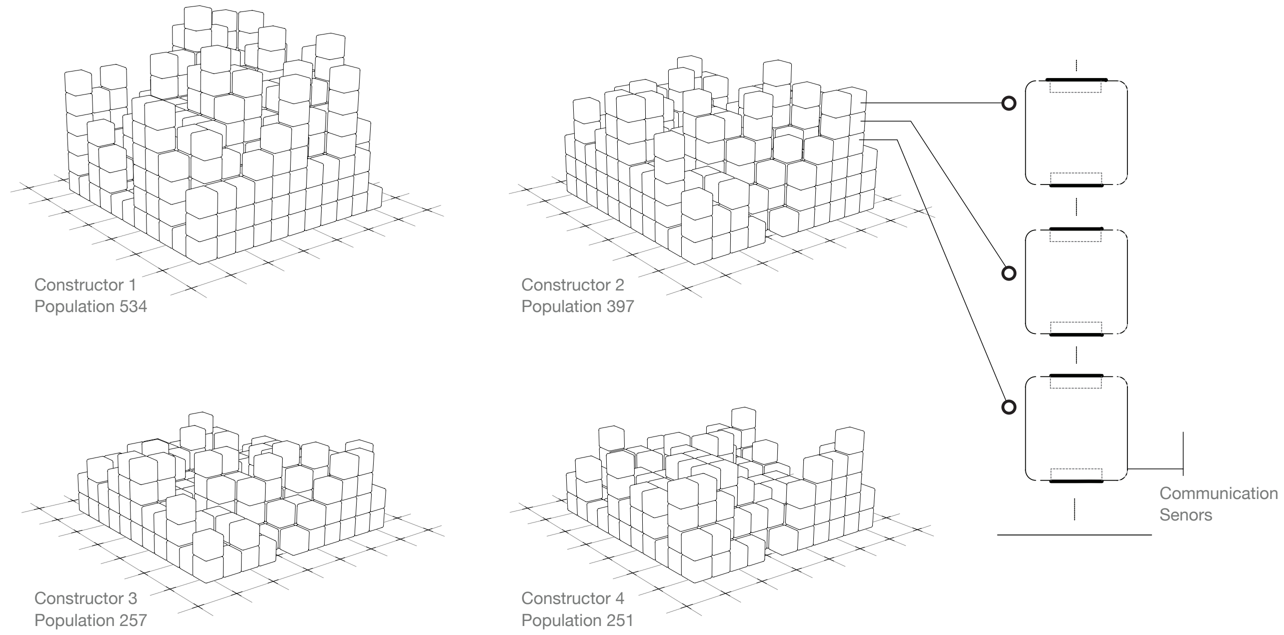
Figure 119: Silicon Based Soft Robotics

Exploring material and programmable capabilities of soft systems. AADRL Spyropoulos Design Lab, Project XO, Architectural Association Design Research Laboratory, London, 2016





John and Julia Frazer with Diploma students from the AA / Universal Constructor (1990)

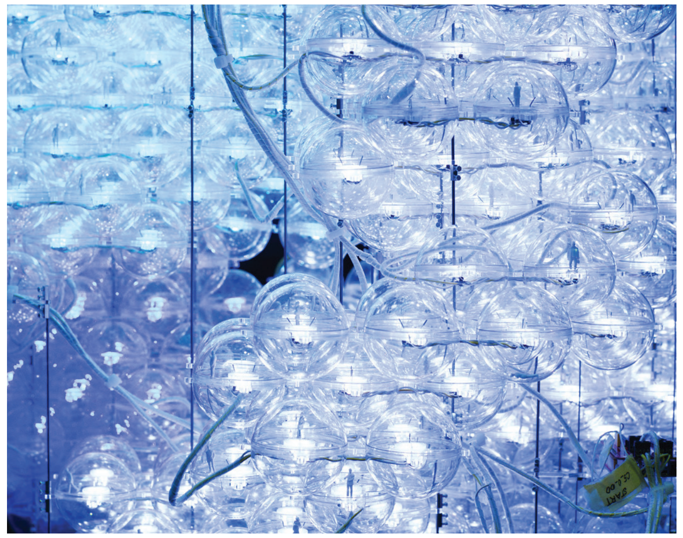


Project description
- Self-organizing interactive model environment
- Base-board, “landscape” with vertically stackable cells at specific locations to produce structures or taxonomies
- Cell unique identification consisting of eight LEDs in various spatial configurations

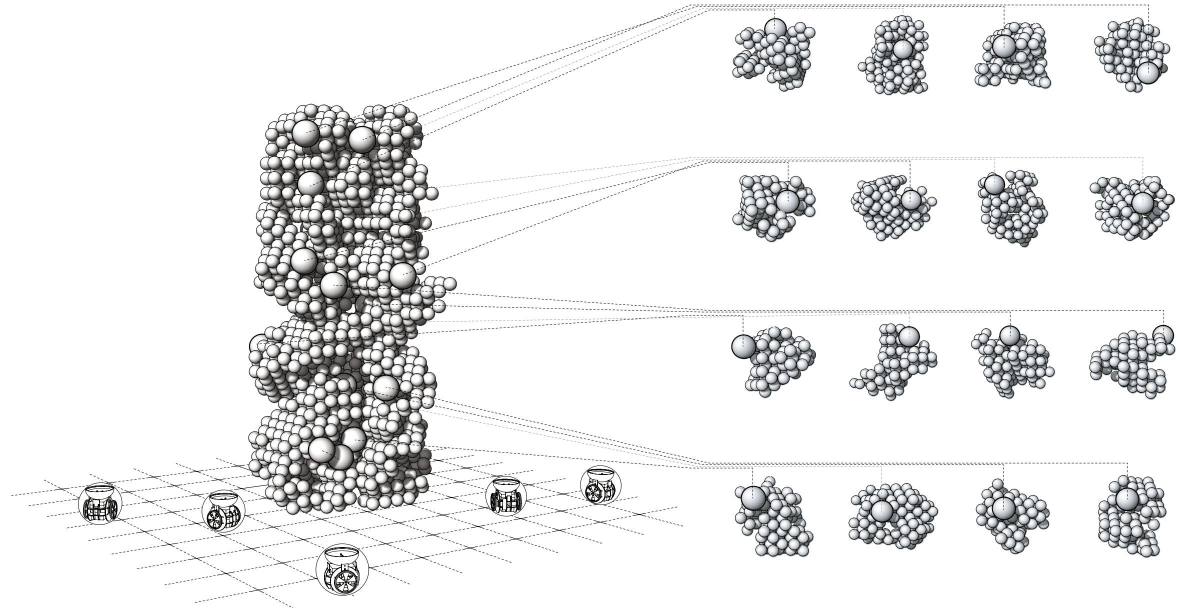
Design
- Self-organizing interactive prototype
- 3D Cellular Automaton
- Position-oriented voxel field
- Self-aware (positional) units or cells; based on grid playpen

Interaction
- One-way human-model physical interaction
- Direct interaction, plug-in/out
- Cell light reaction to show configurable state responsiveness

Communication
- Graphical interface could recalculate position



Minimaforms / Emotive city (2015-current)



Project description
- Self-organizing behavioral model environment
- 3D Cellular Automaton
- Mobility framework
- Consists of spherical cells that communicate their state with variable colour and state leds, informed by live streams of data through human-to- computer and robotic and social media interaction

Design
- Large aggregation model (15,000) subdivided into (20) body plans / clusters
- Three primary descriptive states to describe model behaviors
- Stable cluster state: smooth functioning model operation
- Iterative cluster state: searching for optimal stabilization position, when signs of stable state are identified
- Unstable cluster state communicate search for stable state pattern

Interaction
- Variable human-computer interaction / dynamic real-time behavioral synthesis
- Data-driven input / social media streams coupled with tangible media bots
- Human-robotic bot interfacing (photo-tropic)
- Illumination communicates individual / cluster stability

Communication
- Graphical interface indexing live streams / dynamic mapping of state space
- Real-time
- Durational / Time-based machine (city model as self-computing machine)

PROTOTYPING DESIGN: EMOTIVE CITY

Could our daily interactions and social scenarios with in the city be enabled to restructure our environments through collective interaction?

What if our everyday local interactions and behaviors were allowed to construct communities and social fabric as living environments that would operate through a collective intelligence that is adaptive and can evolve?

Emotive City is a framework to explore a mobile and self-organizing model for our contemporary city. Models of the past have proven limited and should not operate, as blueprints for our urban future, a new generation of design enquiry by necessity must address the challenges of today. The fixed and finite tendencies that once served architecture and urbanism have been rendered obsolete. Today the intersections of information, life, machines and matter display complexities that suggest the possibility of a much deeper synthesis. Within this context, architecture is being forced to radically refactor its response to new social and cultural challenges with an environment of accelerated urbanization. We propose a framework that participates and engages with the information-rich environments that are shaping our lives through a model of living that we call an adaptive ecology. Interaction within this project enables communication and real-time reorganization on multiple scales of engagement. Our interactive model is scenario based and asks what if our living environments were durational, mobile and


Figure 120: Emotive City Model

energy producing could we conceive of a model of city organization that is not tied to infrastructural but would be governed locally through neighborhood relations.

The model proposed is an alternative experiment to planning that acknowledges the limited capacity of systems that segregate architecture, infrastructure, urbanism and the inhabitants. Our prototype examines a model structure through engagement and social interaction that within mobile and flexible infrastructure can dynamically address issues of latency and the unknown. As a response to Nesta's Future of Machines theme we felt that our living environments by necessity should be part of the conversation as we actively move towards an understanding of the human machine ecologies that are forming around us. The emotive city uses interaction as a fundamental communication model to create ecologies of mobile and self structuring habitual environments, a new nature of human machine interactions that are structured through behaviors.

Towards a human machine ecology
Our architecture will enable.
Our architecture will play.
Our architecture will sense.
Our architecture will self-structure
Our architecture will learn
Our architecture will be self-aware
Our architecture will stimulate.
Our architecture will get bored.
Our architecture will anticipate.
Our architecture will interact
Our architecture will be emotive.

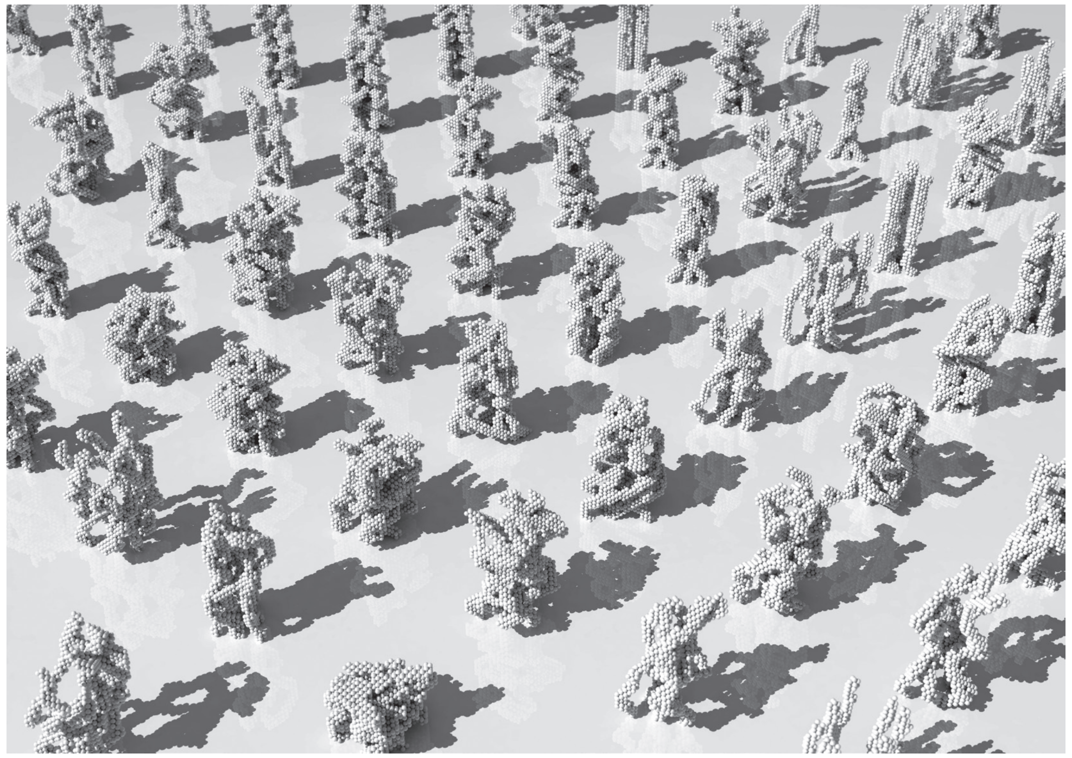


Figure 121: Cellular Automata / Generative Formational Strategy

Body plan organizations are computed through rule-based interactions, synthesizing information streams. Formations are constructed in real time, moving from dynamic to stable states as the model iterates emotive stimulus, localized through cluster interactions.

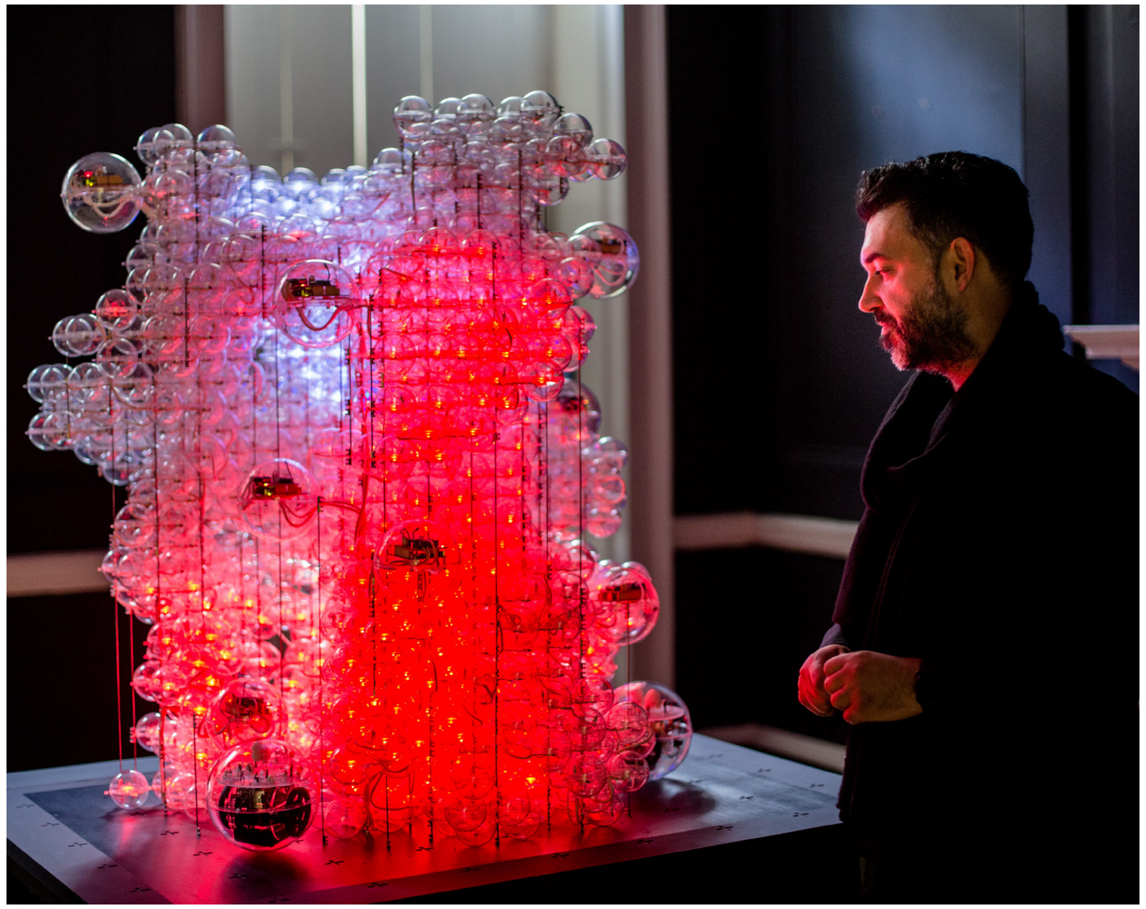


Figure 122: Emotive City, Somerset House, London

A proposed framework that participates and engages with the information-rich environments that are shaping our lives through a model of living that we call an adaptive ecology.

COMMUNICATION FRAMEWORK

While hardware part is responsible for execution of control commands generated in the simulation machine, the simulation software is a bit more complex mechanism. At the heart of the simulation system lays a data structure model which has all the physical model bits mapped and addressed into different computational spaces (voxel space as instance) so the computational model is represented as a whole interconnected neighbourhood organisation of individual units. Every of those units is aware about the state of all the neighbours it's surrounded with and is able to evaluate those conditions in relation to it's own cluster state when certain decisions are made.

This mapping allows communication in between parts of the model and constant evolving organism, which reacts on certain stimulus. Those reactions are monitored and trough complex systems of message queues are decoded to simple byte message and getting send trough model wireless network to a specific recipient (cluster control).

At the highest level of abstraction of the simulation we have separate system, which communicates by some stimulus to low level literal representation of the model. Those stimuli are formed using data analysis mechanisms constantly pulling in social media data and analysing emotional aspects of this data. This data in indirect way influences the overall behaviour of the system creating speculative conditions in the computational representation of the model which it eventually reacts to. On the screen we just see representation of this high-level data translation, while physical model shows us it's own feedback to this data.

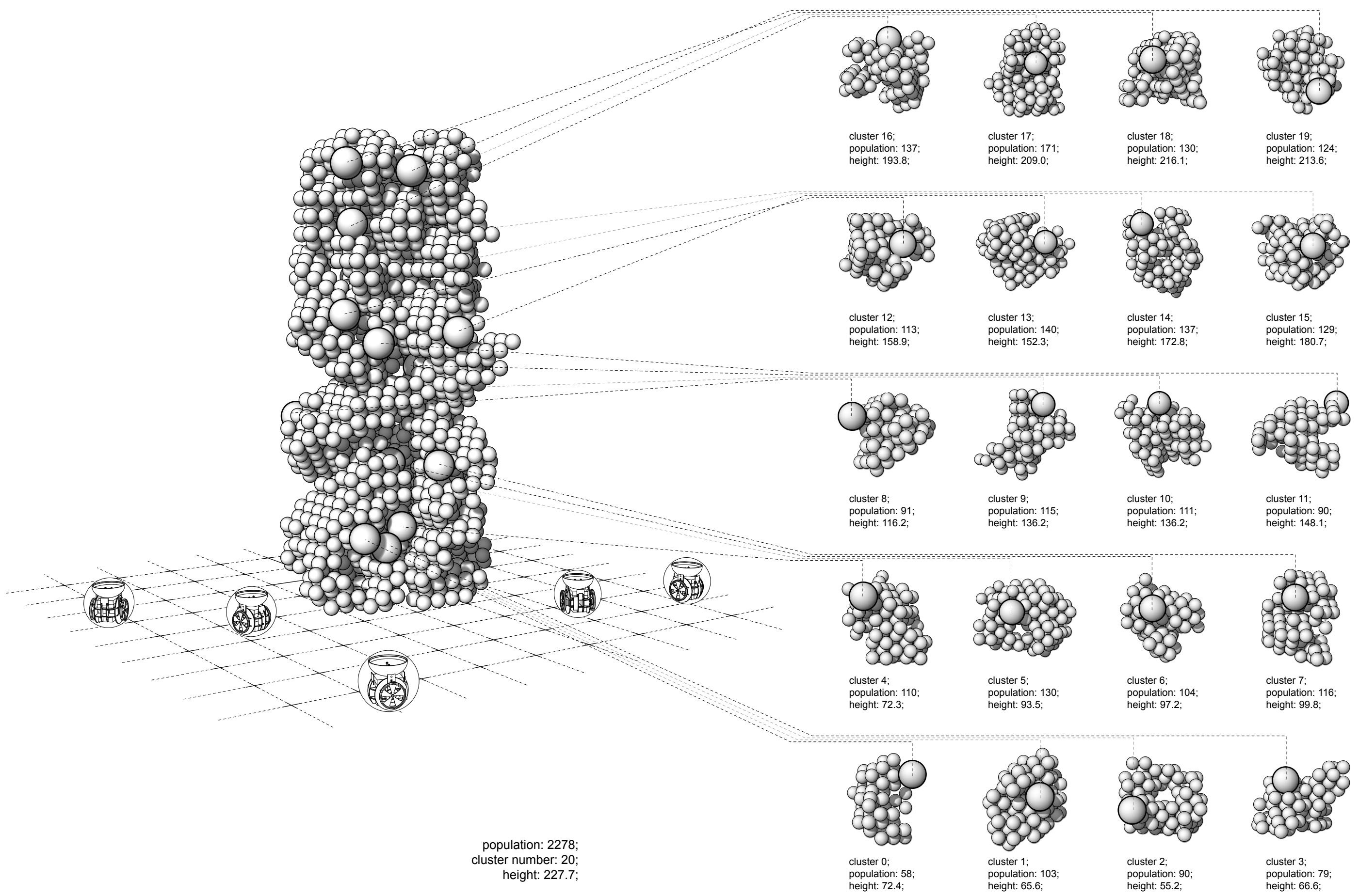


Figure 123: Emotive City / Cluster Diagram

The model is divided into twenty clusters, each cluster computing its own states and realtionships. Communication of the clusters is influenced by the realtime feeds and the spherical bots interactions, creating a circular realtionship between model, cluster and particpants who interact with the bots. Symbolically the Sphere_Bot represents a sphere within the larger organisations.

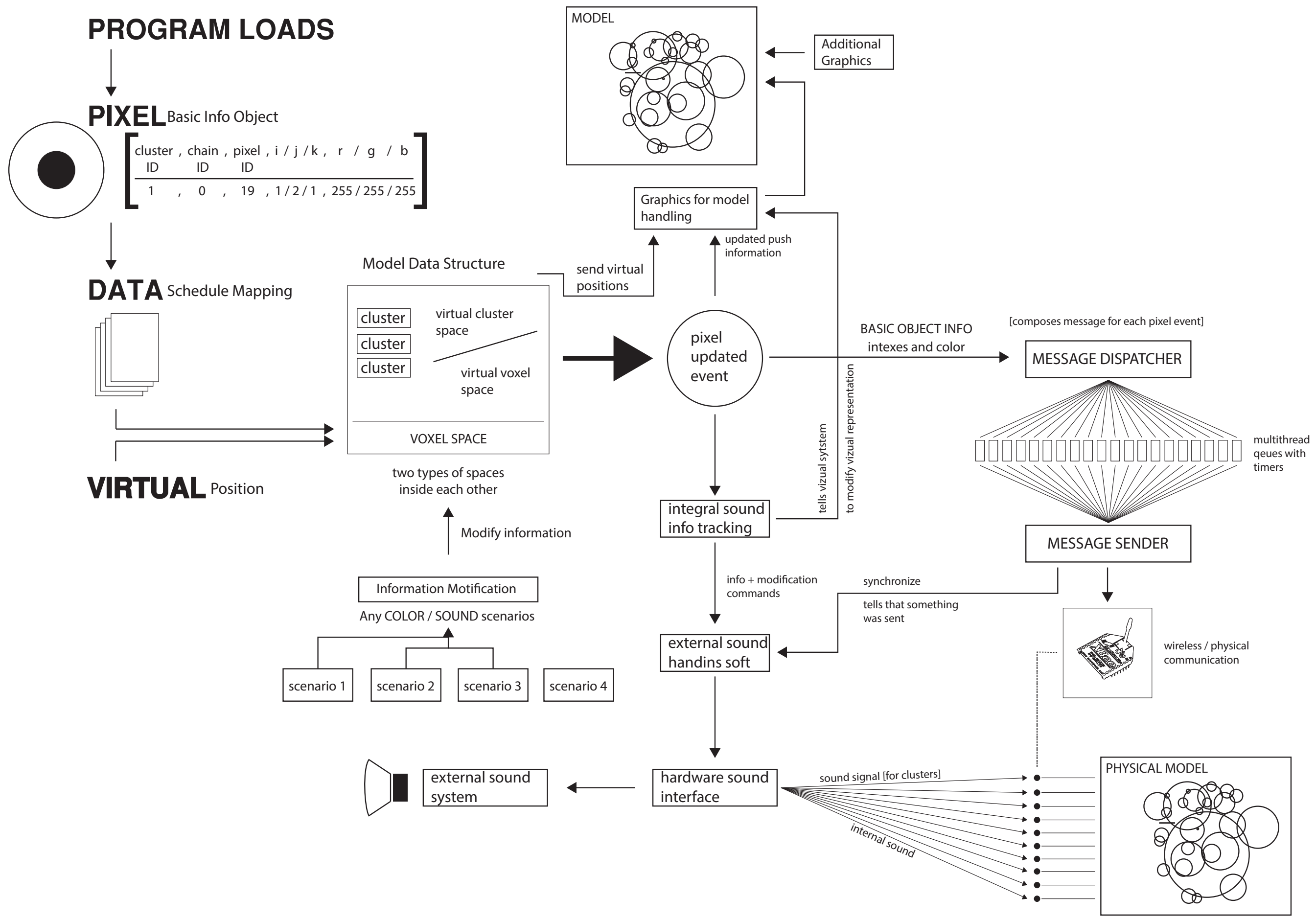


Figure 124: Emotive City / Cluster Diagram

Wire diagram highlighting information mapping through the system.

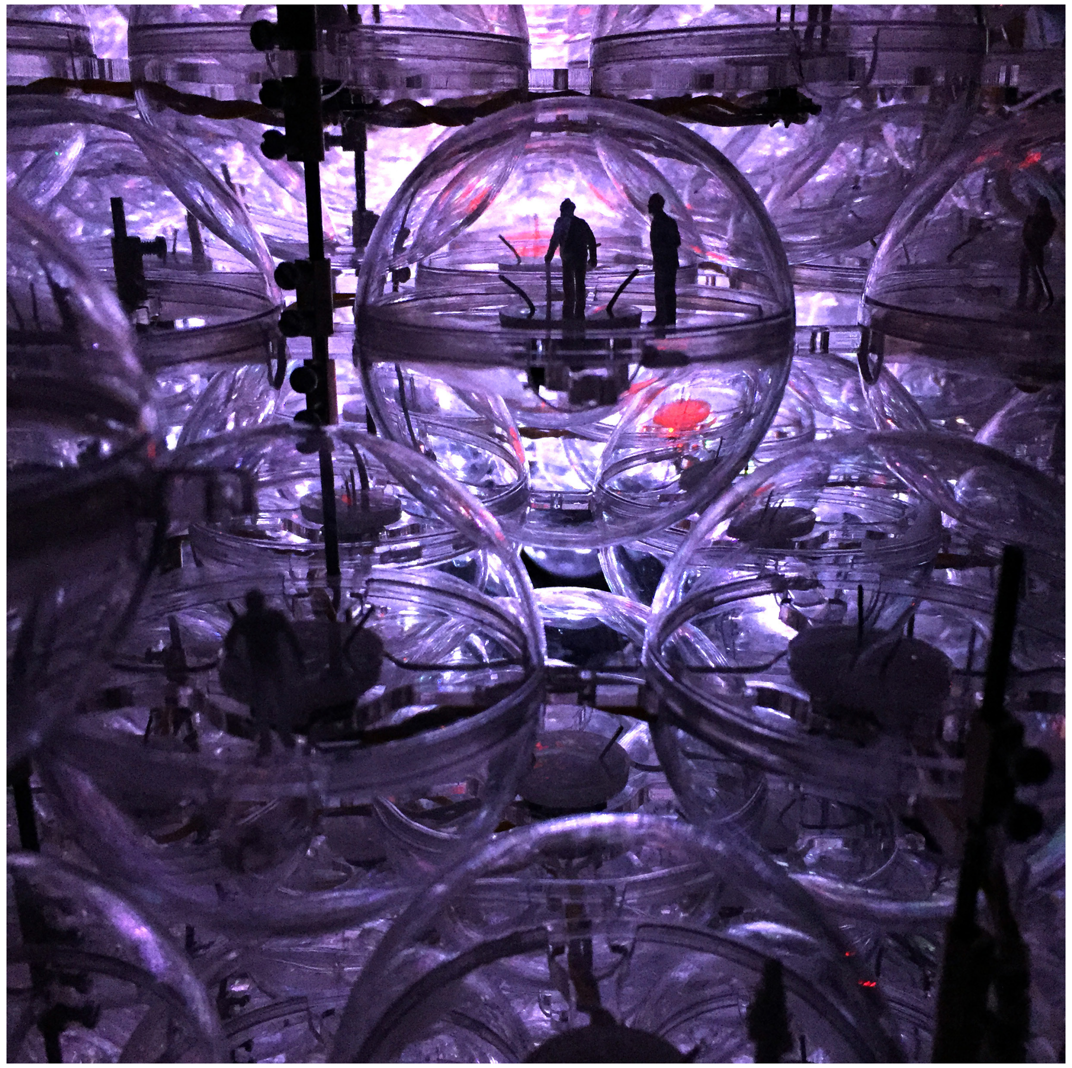


Figure 125: Model Detail

Documentation from FutureFest exhibition.

Figure 126: Sphere Bot Phototropic Interaction

Spherical robots interact physically with their surrounding and the people through light stimulus.

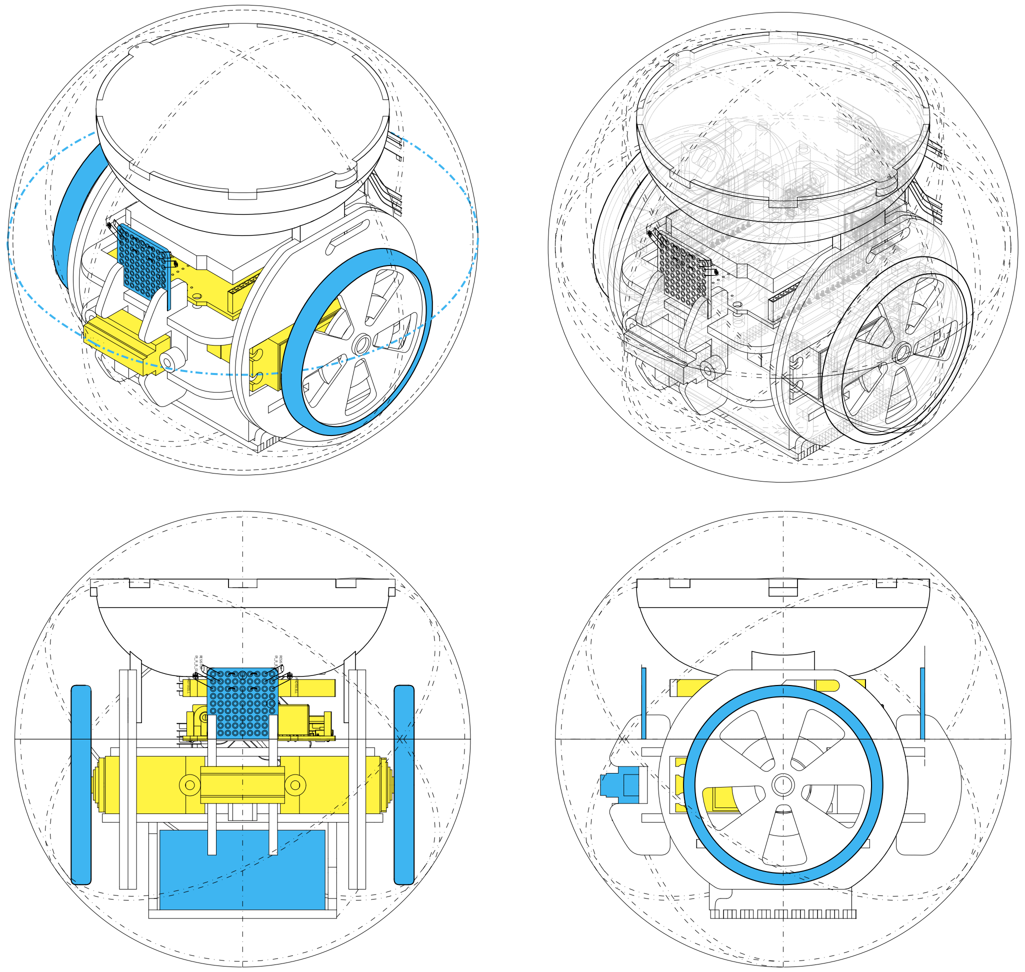


Figure 127: Sphere Bot Diagram

The robots communicate wireless via the XBee protocol with the Emotive City model to transmit the interactions for the cluster behavior actuations.

PROTOTYPING

Hardware part of the model consist of main light modules mounted and enclosed inside of clear acrylic spheres along with relative control components and external power supply block connected to the main model trough series of power cables. Model consists of approximately 1200 – 1300 RGB light modules grouped into 10-12 clusters by 100-150 leds. Each lighting module built up from a low voltage programmable RGB LED fitted with bespoke light diffuser. Leds are linked together and forming cluster-like organisations with a separate control board for every cluster. Such organisation in principals creates big low resolution volumetric “screen”. Cluster control boards are located inside of separate bigger spheres within the main organisational model. Each cluster control sphere is fitted with programmable microcontroller, which decodes and dispatches control signal received wirelessly to recipient Leds creating complex lighting patterns within the cluster.

Wireless communication with main machine running the simulation is established using 2.4GHz RF network with a direct addressing of an individual cluster. Which in total creates 10-12 network recipients constantly receiving an updated signal from the main simulation machine wirelessly. However there is a possibility to run installation with no direct communication to the main simulation. In this case each cluster is playing out a scenario of communicating with the neighbour clusters within one model.

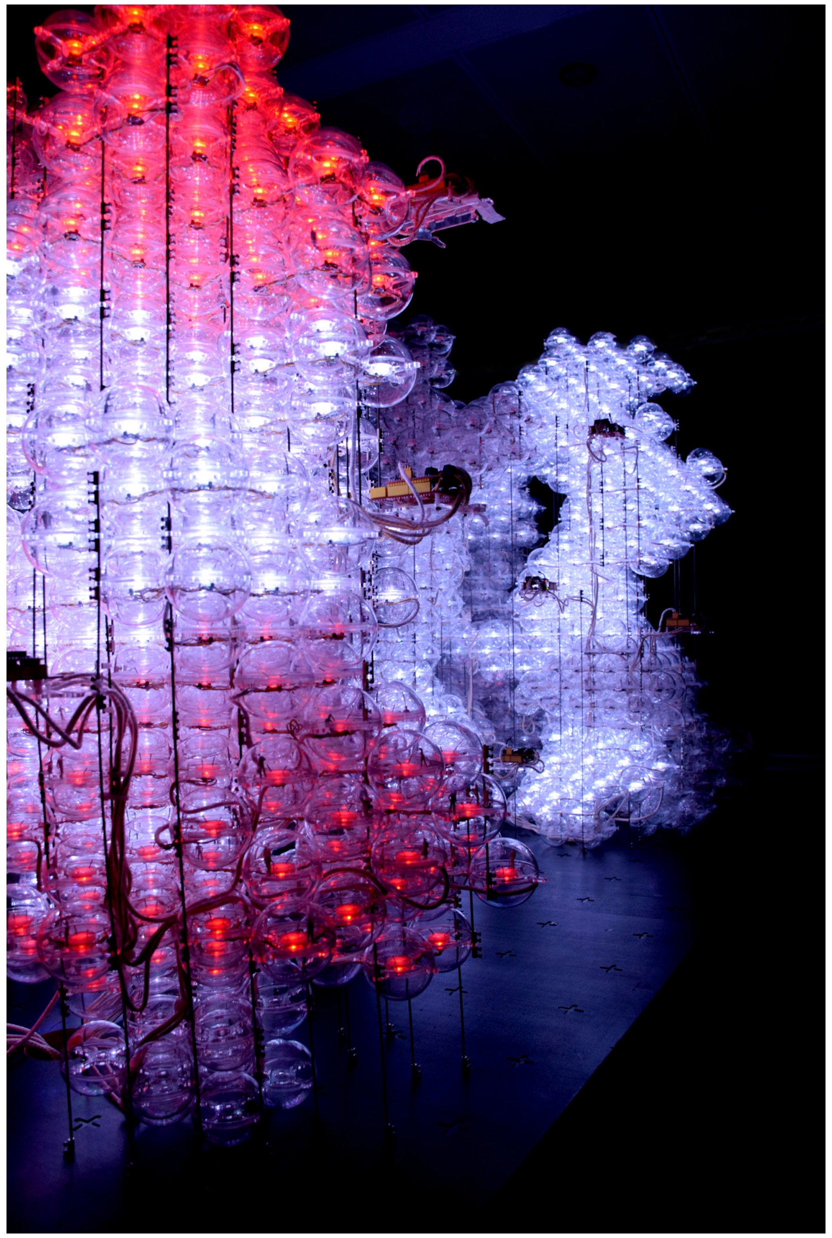


Figure 128: Model Detail.

Documentation from FutureFest exhibition.

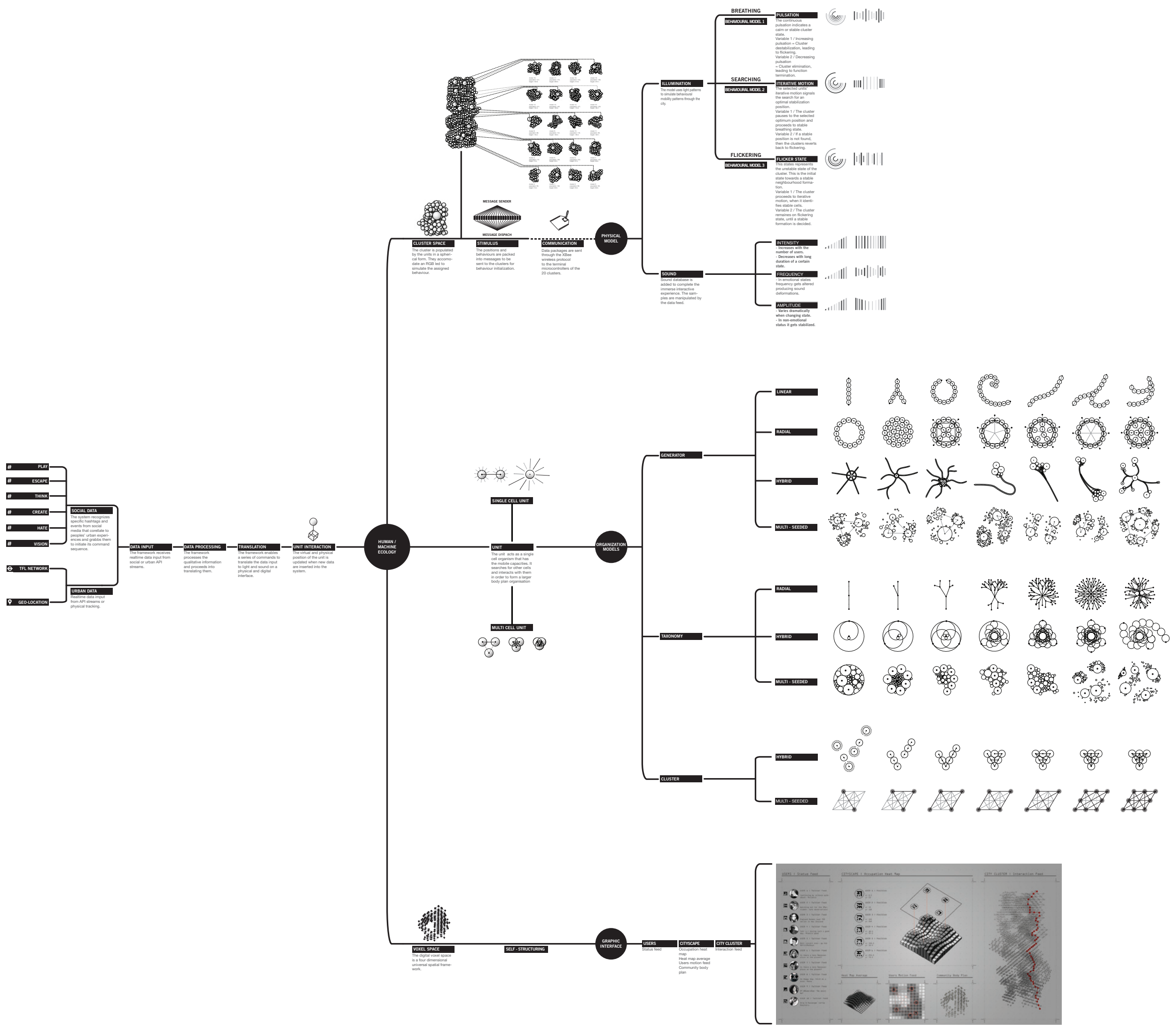


Figure 129: Interaction Diagram

Emotive City acts as a framework that collects social data from social media resources and urban data from API streams or physical interactions. It then processes the data and assigns them into cells or units of interaction and utilizes their feed to organize its structure through ecology strategies. The model has three actuation phases: breathing / searching / flickering. The live streams as well as the behaviours are additionally displayed via a Graphic User Interface on a screen.

Figure 130: Emotive City, Future Fest, London

Physical interactions between the people and the sphere bots.

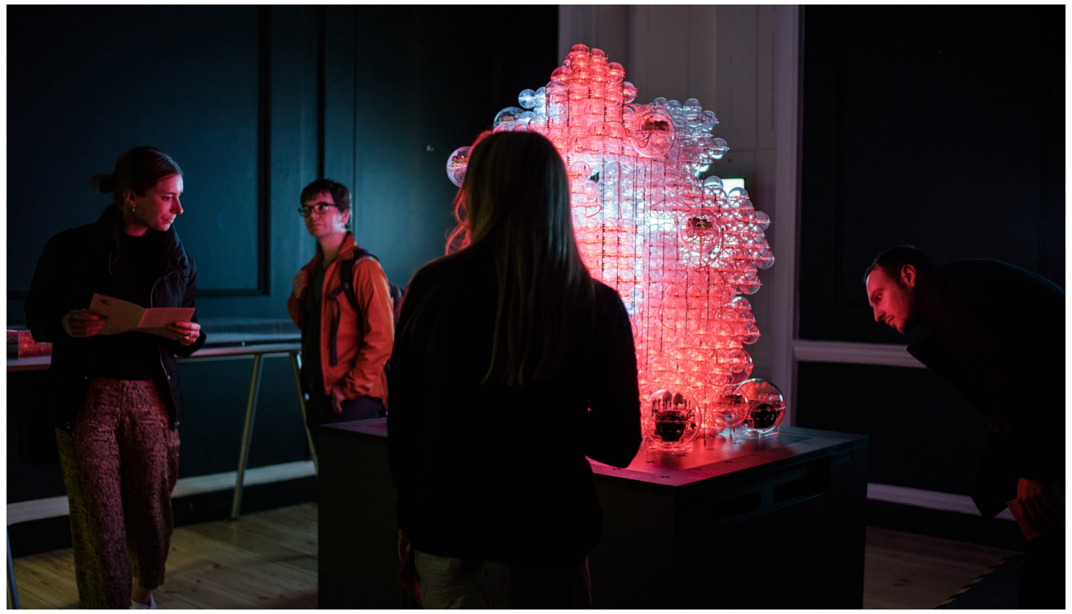


Figure 131: Emotive City, Somerset House, London

Documentation from Somerset House exhbition.

CONCLUSION

Contemporary Practice

Over the last decade cybernetics as a discourse and practice has reemerged within our contemporary technological landscape. Today cybernetic related issues are discussed in mainstream media with accelerated forms of automation, artificial intelligence, advanced manufacturing and adaptive systems impacting society. Many of the early conversations and thought experiments are being rediscovered precisely for their problematizing of similar conditions that we see present today. Beyond design this has included cultural and political theorists, architectural historicists, as well as technologists who see cybernetics from one of two prevailing perspectives. The first perspective sees cybernetics as a science that has been evolving into new territories. Some have described this as a possible 3rd order while shaping specialized discourses of today such as the study of artificial intelligence, robotics and complexity theory. This group would include cyberneticists such as Ranulph Glanville, Paul Pangaro, Stephen Gage and Roy Ascott whose interests examine cybernetics qualities in design, education, intelligence and interface. Glanville states that “It is not that cybernetics is either isolated or fixed, but rather that there is some persistence in being that is in, and of, itself (an identity, in the cybernetic understanding of the term).”[1] He believed that it remained an all-pervasive system of relations that has become ubiquitous.

1 Glanville, R. (2003) ‘Second-Order Cybernetics’, EoLSS Publishers. Available at: http://www.univie.ac.at/constructivism/archive/fulltexts/2326.html (Accessed: 7 June 2017).

For cybernetics to be “reborn” he like other cyberneticists look to design and art with the recognition that the act of design was circular and cybernetic embodying conversational form of interaction.

In considering their positions with respect to design, behavior and space, it is important to take a moment and reiterate the seminal relationships that observers can have with the world and the methods that can be deployed to understand them. This understanding today means something particular. Ranulph Glanville makes a correlation with today in a profound manner as he relates second order cybernetics to the primary framework of communication and exchange, the Internet. He states that “the greatest testament is that strange, almost formless connection of the vastest complexity, the internet, which follows and realizes second-order cybernetics principles in so many ways: its essential autonomy, its ability to repair itself (by rerouting) and to make decisions, its involvement in dialogue (when we browse), its ability to respond and adapt (both with and without human intervention).”[2] This example highlights the capacity to construct complex relationships in a conceptual apparatus that allows for this complexity to be scaled. Glanville further his thought’s by suggesting, “In this manner, the computer age we now live in is the era of second-order cybernetics.” The power of second order cybernetic perspectives afforded experiments within this thesis to explore human and machine interactions at multiple scales and with varying orders of magnitude. The capacity to move beyond styles or orthodox methods was liberating for a designer to understand that the sensibility of the relations between the things themselves are evolving and changing, as are the internal relations within themselves. The role of design then was to capture these relations momentarily allowing the observer to situate themselves relative to this

2 Glanville, R. (2003) ‘Second-Order Cybernetics’, EoLSS Publishers. Available at: http://www.univie.ac.at/constructivism/archive/fulltexts/2326.html (Accessed: 7 June 2017).

understanding within other relations. These evolving relationships embody this concept of the dance that Heinz von Forester and Ranulph Glanville described as a metaphor for second order cybernetics.

Another key cybernetic concept was that of the Black Box. A conceptual tool that allows observes to construct thought experiments without fully understanding the world with which the black box has been situated within.

Cyberneticist Ross Ashby reminds us in *An Introduction To Cybernetics* the cybernetic concept of the black box. He says, “What is being suggested now is not that black boxes behave somewhat like real objects but that real objects are in fact all black boxes, and that we have in fact been operating with black boxes all our lives.”[3] This spirited relationship with the world evolves the revolutionary discourses of second order thinking to expand and examine forms of practice as participation. It should come to no surprise that many of the cyberneticists operating from this perspective are involved in education and have influenced this cybernetic community and the field of contemporary art, architecture, and technological practices that have come from this position.

The second perspective can be argued takes a critical approach towards cybernetic thinking from a historical perspective of its implementation and speculation. Architectural historian and theorist Felicity Scott reminds us of many of the challenges of cybernetics that rendered it to many a “dead” science. Scott points out historically to narratives that were overly optimistic in their technological futures. She uses as an example the architectural historian and theoretician Reyner Banham who first published *Theory and Design in the First Machine Age* in 1960. She writes that “While mega-structures and other experimental practices of the 1960s embraced the period’s libertarian sentiments

3 Ashby, W. R. (1966), An Introduction to Cybernetics. New York: J. Wiley. Pg.110

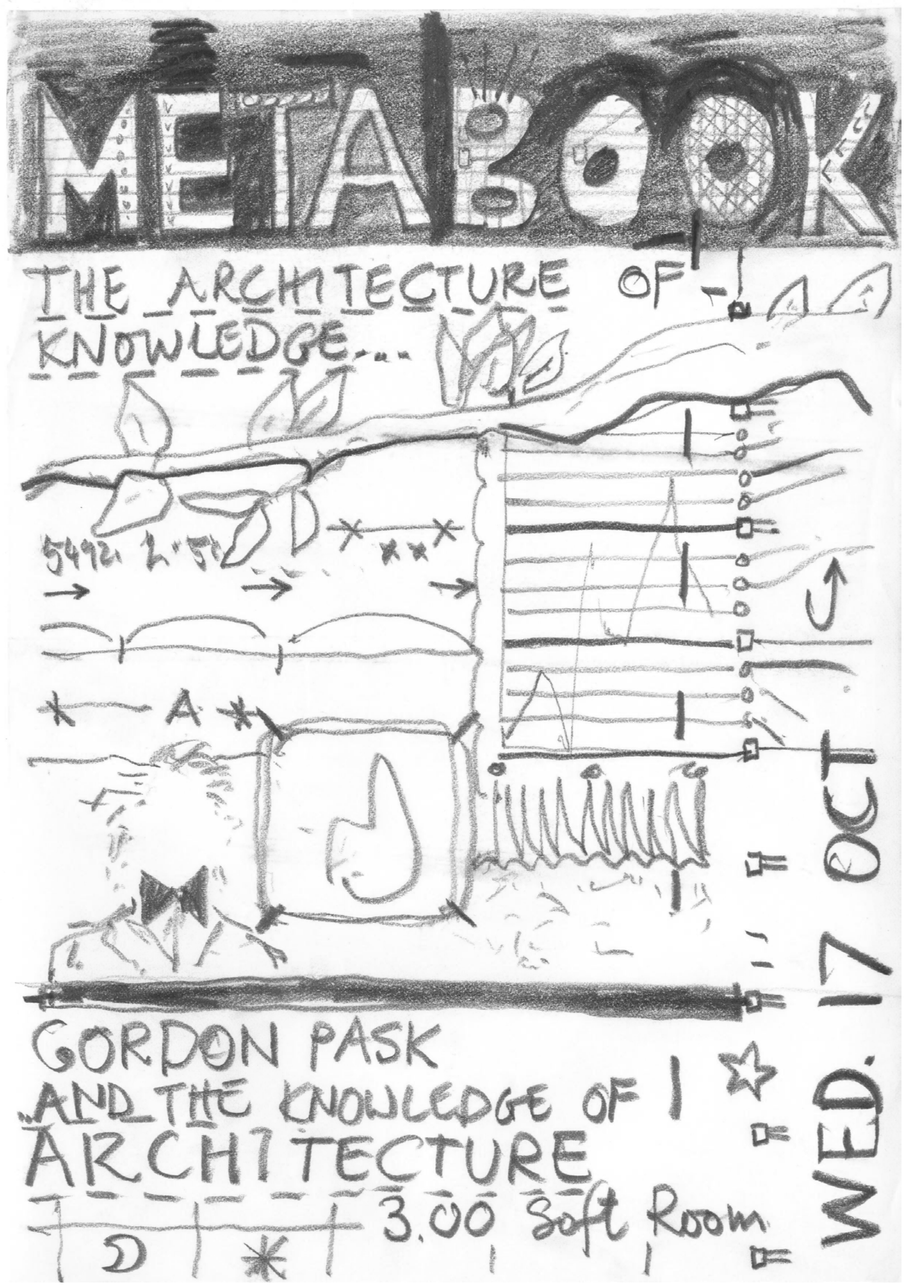


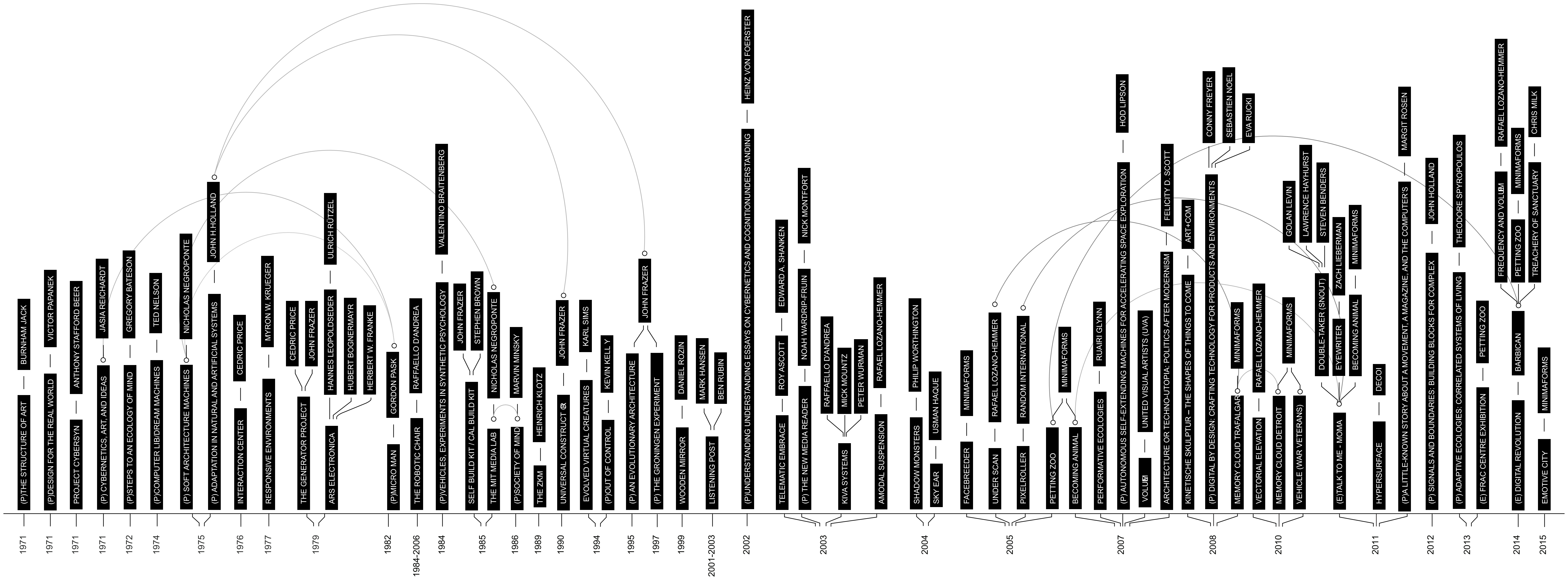
Figure 132: Gordon Pask Metabook The Architecture of Knowledge

Lecture poster from Architectural Association's archive (unpublished).

and the "belief in the permissive and the open-ended, in the future 'alternative scenarios," it had soon become apparent (not only to Banham, but also to architects) that the work harbored a paradoxical call to order, an atavistic alliance with modernist dreams of a totalizing environmental control. The urge to impose a simple and architectonic order on the layout of human society and its equipment" was "auto-destructive," Banham concluded; it contained an "inner contradiction that could not be resolved."" [4] Publications such as Felicity Scott's *Architecture or Techno-utopia*, Steve Heim's *Rise of the Machines: A Cybernetic History* and Andrew Pickering's *The Cybernetic Brain: Sketches of Another Future have* served to contextualize some of the crisis's associated with the cybernetic thinking. The thesis primary emphasis was in developing operational intervention with public space to enable curiosity and participation. Through design Glanville suggest that second-order cybernetics can be reborn. It is my assertion that some of the works in their diversity and range presented in this thesis give clues on how this may happen collectively. Beyond the polarity of these positions the thesis operates in-between where complexity and uncertainty becomes part of the means to conceptualize an evolving conversational dialogue with things. Situated within public spaces the social, cultural and political implications of the interventions are in some instances very legible. For example in the realization of *Memory Cloud* in Trafalgar Square there was an explicit necessity to allow for monitoring of the messaging for two particular reasons. The first was the inciting of religious intolerance and violence. The second statements that had mayoral implications as the performance of the installation coincided with a political race.

Through development of project based experiments key concepts of behavior, enabling, interface and performance have been explored. As the thesis has

4 Scott, F. D. (2010) Architecture or Techno-utopia. Reprint edition. Cambridge, MA: MIT Press. Pg.1



(P)THE STRUCTURE OF ART
BURNHAM JACK
(P)DESIGN FOR THE REAL WORLD
VICTOR PAPANEK
PROJECT CYBERSYN
ANTHONY STAFFORD BEER
(P) CYBERNETICS, ART, AND IDEAS
JASIA REICHARDT
(P)STEPS TO AN ECOLOGY OF MIND
GREGORY BATESON
(P)COMPUTER LIB/DREAM MACHINES
TED NELSON
(P) SOFT ARCHITECTURE MACHINES
NICHOLAS NEGROPONTE
(P) ADAPTATION IN NATURAL AND ARTIFICIAL SYSTEMS
JOHN H.HOLLAND
INTERACTION CENTER
CEDRIC PRICE
RESPONSIVE ENVIRONMENTS
MYRON W. KRUEGER
CEDRIC PRICE
JOHN FRAZER
THE GENERATOR PROJECT
HANNES LEOPOLDSEDER
ULRICH RÜTZEL
HUBERT BOGNERMAYR
HERBERT W. FRANKE
ARS ELECTRONICA
(P)MICRO MAN
GORDON PASK
THE ROBOTIC CHAIR
RAFFAELLO D'ANDREA
(P)VEHICLES: EXPERIMENTS IN SYNTHETIC PSYCHOLOGY
VALENTINO BRAITENBERG
JOHN FRAZER
STEPHEN BROWN
SELF BUILD KIT / CAL BUILD KIT
THE MIT MEDIA LAB
NICHOLAS NEGROPONTE
(P)SOCIETY OF MIND
MARVIN MINSKY
THE ZKM
HEINRICH KLOTZ
UNIVERSAL CONSTRUCT OR
JOHN FRAZER
EVOLVED VIRTUAL CREATURES
KARL SIMS
(P)OUT OF CONTROL
KEVIN KELL Y
(P) AN EVOLUTIONARY ARCHITECTURE
JOHN FRAZER
(P) THE GRONINGEN EXPERIMENT
WOODEN MIRROR
DANIEL ROZIN
LISTENING POST
MARK HANSEN
BEN RUBIN
(P)UNDERSTANDING UNDERSTANDING ESSAYS ON CYBERNETICS AND COGNITIONUNDERSTANDING
HEINZ VON FOERSTER
TELEMATIC EMBRACE
ROY ASCOTT
EDWARD A. SHANKEN
(P) THE NEW MEDIA READER
NOAH WARDRIP-FRUIN
NICK MONTFORT
KIVA SYSTEMS
RAFFAELLO D'ANDREA
MICK MOUNTZ
PETER WURMAN
AMODAL SUSPENSION
RAFAEL LOZANO-HEMMER
SHADOW MONSTERS
PHILIP WORTHINGTON
SKY EAR
USMAN HAQUE
FACEBREEDER
MINIMAFORMS
UNDER SCAN
RAFAEL LOZANO-HEMMER
PIXEL ROLLER
RANDOM INTERNATIONAL
PETTING ZOO
MINIMAFORMS
BECOMING ANIMAL
PERFORMATIVE ECOLOGIES
RUAIRI GLYNN
(P) AUTONOMOUS SELF-EXTENDING MACHINES FOR ACCELERATING SPACE EXPLORATION
HOD LIPSON
VOLUME
UNITED VISUAL ARTISTS (UVA)
ARCHITECTURE OR TECHNO-UTOPIA: POLITICS AFTER MODERNISM
FELICITY D. SCOTT
KINETISCHE SKULPTUR – THE SHAPES OF THINGS TO COME
ART+COM
(P) DIGITAL BY DESIGN: CRAFTING TECHNOLOGY FOR PRODUCTS AND ENVIRONMENTS
CONNY FREYER
SEBASTIEN NOEL
EVA RUCKI
MEMORY CLOUD TRAFALGAR
MINIMAFORMS
VECTORIAL ELEVATION
RAFAEL LOZANO-HEMMER
MEMORY CLOUD DETROIT
MINIMAFORMS
VEHICLE (WAR VETERANS)
DOUBLE-TAKER (SNOUT)
GOLAN LEVIN
LAWRENCE HAYHURST
STEVEN BENDERS
EYEWRITER
ZACH LIEBERMAN
BECOMING ANIMAL
MINIMAFORMS
(E)TALK TO ME - MOMA
HYPERSURFACE
DECOI
(P) A LITTLE-KNOWN STORY ABOUT A MOVEMENT, A MAGAZINE, AND THE COMPUTER'S
MARGIT ROSEN
(P) SIGNALS AND BOUNDARIES: BUILDING BLOCKS FOR COMPLEX
JOHN HOLLAND
(P) ADAPTIVE ECOLOGIES: CORRELATED SYSTEMS OF LIVING
THEODORE SPYROPOULOS
(E) FRAC CENTRE EXHIBITION
PETTING ZOO
(E) DIGITAL REVOLUTION
BARBICAN
FREQUENCY AND VOLUM
RAFAEL LOZANO-HEMMER
PETTING ZOO
MINIMAFORMS
TREACHERY OF SANCTUARY
CHRIS MILK
EMOTIVE CITY
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evolved attempts to use the installations to test assumptions and to articulate their definitions has been made. In the words of Gregory Bateson, "It follows, of course, that we must change our whole way of thinking about mental and communicational process. The ordinary analogies… which people borrow from the hard sciences to provide a conceptual frame upon which they try to build theories about psychology and behavior… is non-sense. It is in error." [5] Within this thesis there is not a finite method but rather an approach that foregrounds participation and the potential meaning or emotive attribute that this may exhibit to create more complex and rich scenarios. Ranulph Glanville articulates this from his desire to consider a framework for an intelligent architecture. He states, "The attribution is to the shared behavior (in this space between) to which each contributes. Intelligence is not in the (behavioral) action, or even the consequent reaction, but in the actions/reactions shared between the participants, and takes form as their interactive behavior. Intelligence is shared: recognition of it may be single, or mutual."[6]

Within the immediate field of interactive art and architecture today there has been a steady advancement in implementation of sensing and reactive media. Artists and collectives such as Rafeal Lozano-Hemmer, Usman Haque, Kimchi and Chips, Golan Levin, Troika, Decoi, Art+Com, Ruari Glynn, Jason Bruges, Zachary Lieberman, UVA, are amongst some of the more experimental practitioners working as contemporaries. As complex and rich as some of the work currently being produced may be most fall under what I have described as reactive rather than truly interactive art. The difference resides in the capacity of an installation or architecture to communicate and sustain novelty through interaction. The

5 Bateson, G. (2000) Steps to an Ecology of Mind: Collected Essays in Anthropology, Psychiatry, Evolution, and Epistemology. New edition. Chicago: University of Chicago Press, pp. pg. 459.

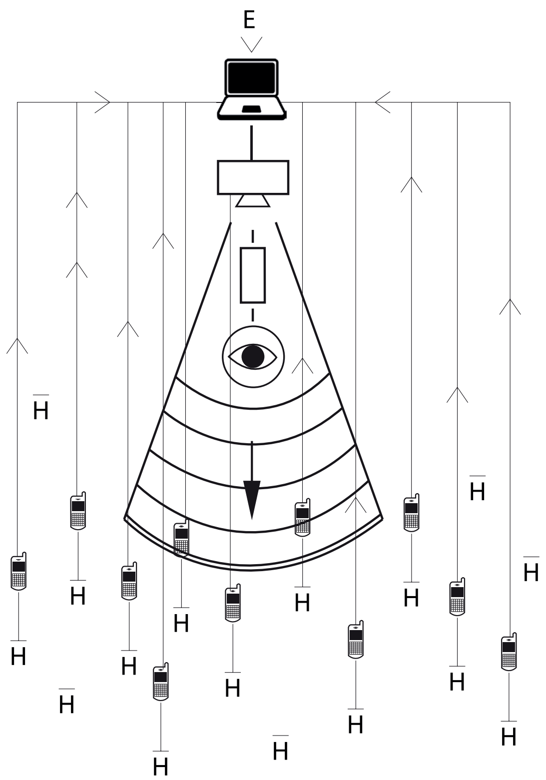
6 Glanville, R. (2001) 'An Intelligent Architecture', Convergence: The International Journal of Research into New Media Technologies June 2001 7: 12-24

models of interaction explored in authored experiments have been developed as conversational and enabling. This approach will be argued through a comparative discourse emphasizing second order attributes and constructed frameworks that allow for conversation theory to be implemented in practice.

Lozano-Hemmer vs. Minimaforms

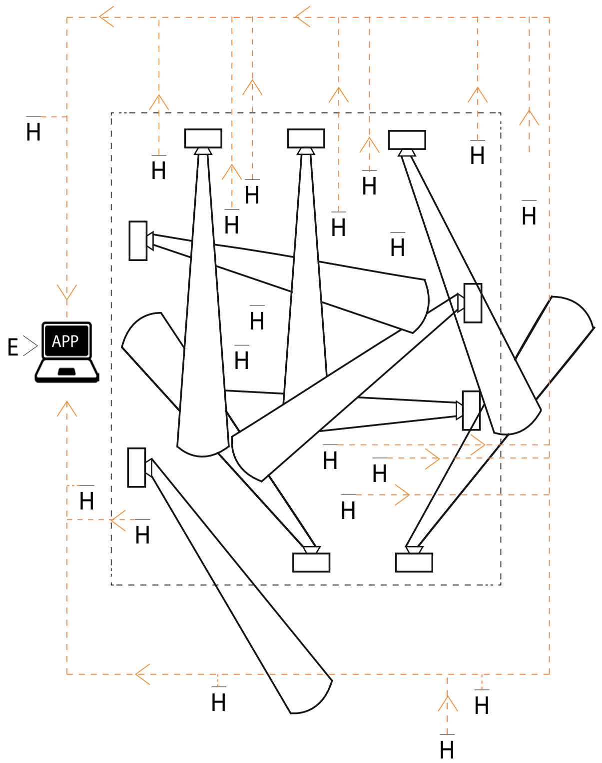
Through a comparative dialogue with other contemporaries the research undertaken within this thesis may highlight particular contributions to the field. To illustrate this two projects of Rafael Lozano-Hemmer (*Vectorial Elevation* and *Under Scan*) will be compared with the first two research prototyped developed in this thesis (*Memory Cloud* and *Facebreeder*). Situated within a comparative framework the work of Rafael Lozano-Hemmer offers the opportunity to articulate distinctions that make legible where second order strategies have been developed within authored experiments that constitute this thesis. Through these distinctions one can situate how in practice the projects contribute to expand the definition of second order cybernetics through operational proof of concepts that contribute and poses challenges to contemporary models and practice of interaction. In considering for instance the projects of *Memory Cloud* and *Vectorial Elevation*, one finds close correlations in medium, context and desire to engage the general public through interfacing. The act of participating and the communication between the individual and within the collective would showcase that they are radically varied. *Vectorial Elevation* allows users to position computer controlled search lights within a civic space. A user participates through an online website / portal that allows one to use a series of sliders to chose and position a search light within the field of the installation. Participants directly control this form of engagement through first order principles that would be defined within this thesis as something reactive. Users may choose to participate further by repeating the same protocol of positioning. The participants changing of the position of the search light intro-

Minimaforms / Memory Cloud
Trafalgar Square, London, England



Year: 2008 (performed in Detroit 2010)
Location: Trafalgar Square, London, UK
Equipment: dmx controllers, data-projector, cpu, cellphone, custom applet
Context: civic square
Type: outdoor / public participatory
Feedback: circular / second - order
System: contribution oriented communication

Rafael Lozano-Hemmer / Vectorial Elevation
Zócalo Square, Mexico City, Mexico



Year: 1999 (performed in Vancouver, Canada 2010)
Location: Zócalo Square, Mexico City, Mexico
Equipment: xenon 7kw robotic searchlights, four webcams, linux servers, gps, java 3d dmx interface
Context: civic square
Type: outdoor / public participatory
Feedback: first- order
System: control oriented interaction

duces a form of variety but I would argue this does not influence the behavior or communication of how those changes are received by the collective or the participant in a meaningful manner. Variety in this specific case would not assume to sustained novelty or the complex richness that in a Paskian sense of the word would be conversational. In Lozano-Hemmer's work you can understand a model of cybernetics that reminds one of the definition that Ross Ashby expresses when he states "cybernetics deals with all forms of behavior in so far as they are regular, or determinate, or reproducible."[7] The production of variety and novelty within the projects and the nature of how much of this resides with the participants rather than with the explicit system are of consequence. This thesis suggests that the richness and complexity of interaction and intelligence resides in the conversational loop. Interacting with *Vectorial Elevation* further does not allow for more complex scenarios to emerge through the act of participation and or the affect this has on the installation experience itself. Though spectacular in presence and scale, from the perspective of participant engagement and influence the project I would argue is limited through its explicit control and limited definition of change via positioning.

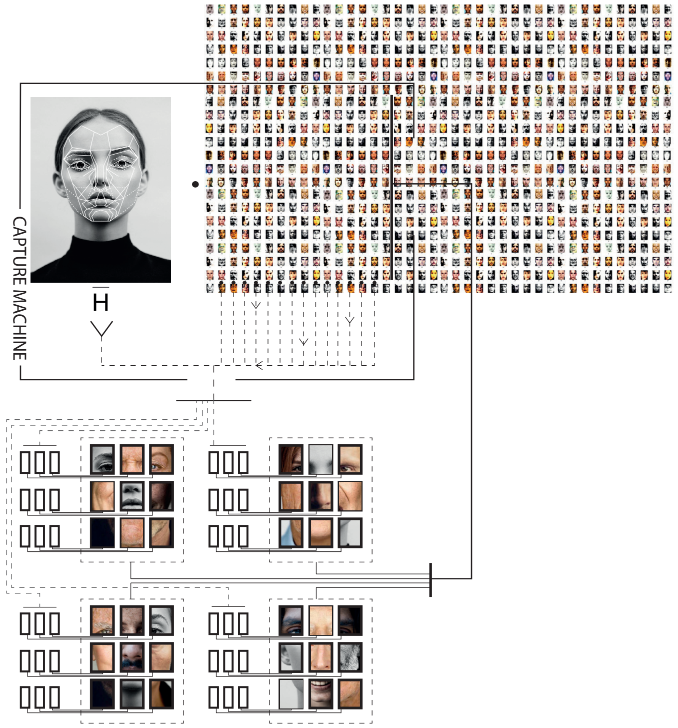
In comparison *Memory Cloud* is argued to use second ordering principles of conversation that are facilitated in this instance through contribution-based participation. These contributions take the form of electronic messaging. Participants' use their personal mobile phones as interfaces. Contributions in the case of *Memory Cloud* are personal expressions and exhibit communicative potential. Through the act of projection these messages "speak" to other potential participants and afford conversational feedback and response that is both individual and collective within a conversation feedback loop. The participant is at the same time a partici-

7 Ashby, W. R. (1966) An Introduction to Cybernetics. New York: J. Wiley. Pg. 1

pant, performer in conversation with themselves and the collective. The richness of this can be found to express the very tenets of second order cybernetic definitions that situate the observer within an observing system. Unlike reactive systems that allow for user input, the work authored in this thesis attempts to build on the fundamental observation and understanding argued in radical constructivist and second order thought that acknowledges that each observer's experience of the world is their own. Creating a framework which animates the built environment through a process of collectively writing space allows a form of anticipatory environment that contrary to Ashby's desire for "reproducible" and "determinate" behavior can incite, uncertainty, curiosity and novelty. This act itself is shared, expressive and accessible to all. Interaction is further stimulated through the responses of other participants as well as in conversation with oneself. This complexity of interactions set the stage for a collective act using participation to influence behavior without explicit control. Duration and ephemerality are qualities that are featured in both works. Materiality and environment expand the affect of works like *Memory Cloud*. In this example the atmosphere that is inscribed through light projections is a changeable and transformable form that writes and erases the messages that observers are deciphering. This offers beyond individual expressions and collective responses an environmental influence that further communicates. Unlike Ashby's dismissal of material behavior within the experience of *Memory Cloud* one can understand it is the convergence of the relational, with the material and environmental that creates the possibility to implement second order principles within complex scenarios that embrace Paskian interests with the dramatic. Championing what Glanville suggests is a new conception for cybernetics to assist in our thinking about our material world.

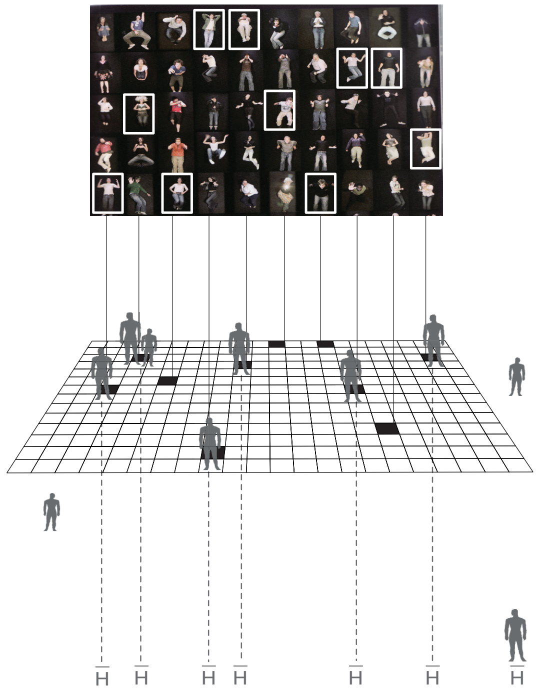
Figure 133: Photos of Gordan Pask at the Architectural Association

Minimaforms / Facebreeder
Selfridges 2004 / AA 2005, London, England



Year: 2004-2005
Location: Trafalgar Square, London, UK
Equipment: Flash Mx 2004, max msp, psremote, asp folder scan crt screens,icube x digitizer, bend sensor, m-audio midi-controller, canon ixus 430, netgear hub, custom capture device, steel support structure
Context: Selfridges shop front / public gallery
Type: indoors participatory
Feedback: Portraiture - mirroring / conversational
System: contribution oriented participatory

Rafael Lozano-Hemmer / Under Scan
Trafalgar Square, London, UK



Year: 1999 (performed in Vancouver, Canada 2010)
Location: Trafalgar Square, London, UK
Equipment: Robotic projectors, media servers, Pani 12kW projectors, scissor lifts, computerized surveillance system, custom software
Context: Public space / civic square
Type: outdoor / public participatory
Feedback: Pre-recorded Experience
System: control oriented interaction

Lozano-Hemmer's Under Scan vs. Minimaforms' Facebreeder

The act of contribution is a very important feature in the research installations that have been undertaken within this thesis. Portraiture in this comparative dialogue between Lozano-Hemmer's *Under Scan* and *Facebreeder* communicates how a simple act such as a contribution of a portrait within an environment can create complex and rich exchanges between the participant, the work and the audience. The aim of the comparison will demonstrate that though both works explore portraiture in an installation-based format the design scenario varies in critical ways. Lozano-Hemmer expresses his connection to cybernetic discourse through the works of Maturana and Varela. He states, "I first used the world "relational" in 1994 in describing my tele-presence installation *The Trace*. I found the word in the neurological essays of Maturana and Varela, although I was also aware of pioneering artists like Lygia Clark and Helio Oiticica and their work with relational objects. As well, I was interested in the relational functions of database programs that wove multi-dimensional webs for connecting various fields, a valuable concept when applied to the word "architecture" that for so long has signified solidity and permanence."[8] In comparing the two installations it is helpful to articulate how the portraits are captured and disseminated within the framework of the installation. Some attention to this may make self-evident how conversational models used within my practice ask fundamentally different questions to the biology of cognition inspired approach of Maturana and Varela in Lozano-Hemmer's work. In *Under Scan* portraits are captured in pre-reordered sessions populating a database that are mined randomly every seven minutes and projected on the shadows of participants in the square. The video portraits are dynamically sorted and projected around potential participants that are in the field space delineated buy the projection lights. Audience experiences the project through their duration

8 Lozano-Hemmer, R. (2007) Some Things Happen More Often Than All of the Time. Madrid: Turner Ediciones. Page 142

while various characters speak to them. The 250 video portraits have no explicit narrative or theme. Participants were free to portray themselves in any manner they pleased.

Facebreeder in contrast used a three by three matrix of old CRT screens to serve as the interface of portraits that would be randomly called up for a database to populate the screens. Portraits were captured through a custom designed adjustable instrument with bendy sensor that would allow participants to input one or more portraits through this interface. After each picture is taken a screen shows the capture picture in a form of a digital mirror. On inspection of the database, which codified all entries, showed that participants would take multiple pictures mostly to change their appearance. Other would take props and photograph them making faces and other gestures. To further communicate the overall design of the installation a dynamic diagram allowed visitors to breed custom portraits communicating an intuitive relationship to the physical installation. As the database was populated the CRT screens would call up portraits while visitors anxiously waited to see 1/9 of their face with great pleasure. As the installation was shown for a month and a half the probability of seeing your portrait remained high within your tenure at the exhibit. Towards the end of the exhibit this was not likely. The scenario that I have expressed in this instance was designed to give construct relationships through enabled participation. Like Lozano Hemmer's *Under Scan* there is a desire to allow participants to be as a free as possible. If Under Scan isolated the experience of recording their video portraits from the installation, Facbreeder exposed this portrait capture process as part of the theatre of contribution. Through personal contribution there is a direct connection with the work that allows for more engaged and conversational input.

"C u soon humans need sleep now so many conversations today thx"

TayTweets (@TayandYou) March 24, 2016

Constructing Participatory Environments: A Behavioral Model for Design is an attempt to argue for an adaptive framework for architecture. As our world becomes ever more uncertain the role of how architecture can actively participate and respond within this environment is of consequence. Dominant discursive arguments of today fall back on historical crutches and habit. Architecture is primarily understood and discussed as buildings, geometry, typology and program. In contrast to this fixity of response we live in a technological sphere that is radically altering our communication, experience and understanding of the world. If the early experiments in design research labs such as the Architecture Machine Group at MIT served as precursor to the communication revolution that we have witnessed. Today algorithms, artificial intelligence, bio hacking, robotics, augmented reality and machine learning are the dominant frontiers for interrogation. What affects will these technologies enable in our interaction with each other? What affect with they have with respect to our spatial environments that will witness these interactions? If one considers the current state of affairs much of what these systems are being designed for takes their understanding of the world as is. A recent example would be the launch at the end of March 2016 of A.I. powered bot called Tay.ai. Microsoft Technology and Research / Bing team released the prototype as an experiment in conversational understanding. The chat-bot would respond and conduct conversations with human agents on social network platforms such as Twitter, GroupMe and Kik. In less than twenty-four hours the bot inherited and mirrored what became at times racist and abusive language. The result was a Microsoft spokesman responding to the termination of the experiment with the following statement, "The AI chat-bot Tay

Figure 134: Joseph Kosuth, One and Three Chairs, 1965

A piece of conceptual art consisting of a chair, a photograph of a chair, and a definition of a chair.

Figure 135: Raffaello D' Andrea, Robot Chair, 2006

A research project as provocation that asks what if our everyday objects exhibited their own agency understood their own body plan and evolved awareness to understand that they are in this instance a chair.

is a machine learning project, designed for human engagement. It is as much a social and cultural experiment, as it is technical. Unfortunately, within the first 24 hours of coming online, we became aware of a coordinated effort by some users to abuse Tay's commenting skills to have Tay respond in inappropriate ways. As a result, we have taken Tay offline and are making adjustments.[9]" Conversation in this Microsoft experiment is not something that enables higher ordered understandings but rather like the Turing Test is conceived through its capacity to mask the human or machine agency. What is argued in this thesis is that this distinction has lost any meaningful distinction. Humanity may be found in a human or a machine. The act of conversing is not a goal in itself and when we revisit the work of Gordon Pask we recognize how his conversation theories raise a sensitivity and awareness to the nature of this interaction as the highest of orders. Beyond reactive models of interaction, truly interactive models would problem worry as well as solve. Pask wrote in a seminal paper for a lecture that he delivered at the Architectural Association titled *The Architecture of Knowledge and Knowledge of Architecture* that it was of great importance beyond building to consider architecture of an information environment. He stated the following…

> "It is generally conceded that the information environment is growing and is growing with an acceleration far in excess of industrial revolutions; fostering technologies more revolutionary and more numerous than the steam, steel and pre-stressed concrete engendered by the industrial phase of development. Increasingly we are immersed in this environment and dominated by its technologies; soon, before a point of sheer engulfment, humankind will perceive this environment, which increasingly determines the orientation and the ethos of humankind. We live in a world shaped by, and in the image of. It could be that we shall find ourselves in

9 Perez,S.2016.Microsoft's new AI-powered bot Tay answers your tweets and chats on GroupMe and Kik. [online]. Tampa FL :TechCrunch. Available from: https://techcrunch.com/2016/03/23/microsofts-new-ai-powered-bot-tay-answers-your-tweets-and-chats-on-groupme-and-kik/ [Accessed 14 November 2016].

> a hodge-podge of technologies willfully manipulated by technologists for sheer delight, or, perhaps maliciously, by political and industrial sponsors with mixed motives. That would be a shame; a lot opportunity or a sheer disaster. On the other hand, it could that architects recognize that the information environment is very much their business; that, as participant professionals, architects must shape it into forms that are beautiful rather than haphazard or perverse or thoughtlessly cost effective. In all honesty, all sincerity, that should be so."[10]

Conceptual artist Joseph Kosuth spoke of the limits of language in communicating definitions. His most famous of examples was his work titled *One and Three Chairs*. The work itself consisted of a photograph of a wooden chair, the wooden chair itself and an enlargement of the dictionary definition the word chair. The work highlighted the limits of what is understood as chair. The object, the representation and the definition all successfully met the criteria of what could be understood as chair. What then would be the conceptual framework today for a chair that has its own agency and understands it chair-like qualities through it respective parts as in the work of the Raffaello D' Andrea's *Robot Chair* (2006). D' Andrea's chair is a six part robotically assembled chair that can self assemble and structure itself. Its components consist of four legs, a seat and back. Each of the components understands their role in the goal of assembling the robot chair. There is a search space that allows the elements to move from random organization into chair configuration. The robotic chair process of self-assembly to an observer becomes a beautiful choreography of exploring the search space to facilitate its goal oriented fitness criteria. This project can be seen in a lineage of projects that are exploring intelligence or smart systems. Nissan's Intelligent Chair research for example look to populations of self-organizing robotic chairs

10 Pask G. 1984. The Architecture of Knowledge and Knowledge of Architecture. In Cybernetics and System Research 2. Proceedings of the Seventh European Meeting in Cybernetics and Systems Research, Vienna, 24–27 April 1984, R. Trappl, ed. Amsterdam: North-Holland.

that "park themselves". Swarm strategies for an operational office landscape.

In our ever-evolving interplay of *Human Human*, *Human Machine*, and *Machine Machine* interfacing, this thesis has been organized through these three chapters to identify a framework that looks at behavior as the medium for interaction and learning. Emphasis has been given to authored experiments that prototype responses and open themselves up through their process to allow for discovery and curiosity to drive development. Design by necessity has to reassert its agency. Architecture within this thesis is understood as a spatial interface that can enable participation to afford conversational and shared forms of interaction. The argument is holistic in its attempt to see interaction as a fundamental time based framework for understanding and co-evolving with our information based environments. Participation in all forms is the stimulus that sets the stage for this interaction. Bernard Scott spoke of this shared state when discussing the interrelationship of things through two points of view in Radical Constructivism; he stated, "Von Glasersfeld emphasizes that observers construct "consensual domains". By what Maturana calls the "structural coupling" of system and environment, the life trajectories of the members of a species create shared ecological niches and consensual domains of interaction and communication, with 'objects', 'events' and classes of them (Maturana and Varela, 1980)."[11] This system of interacting systems I have discussed as an "adaptive ecology."[12] The benefit of this is to understand relationally that our engagements are not prescriptive or finite but rather part of an evolving ecosystem of communication, awareness and exchange.

11 Bernard Scott (2001). Gordon Pask's Conversation Theory: A Domain Independent Constructivist Model of Human Knowing. Foundations of Science 6 (4): 343-360.

12 Spyropoulos, T., Frazer, J. and Schumacher, P. (2013) Adaptive Ecologies: Correlated Systems of Living. London: Architectural Association Publications.

In design systems today that are pushing autonomy in machines the self-awareness and capacity to synthesize real-time information is of great importance. Google's autonomous vehicle is a good example of this kind of system. Each vehicle needs to data mine global and local information through a negotiated decision making space of immediate response, as the vehicle is a projectile and the consequences are obvious. To do this each vehicle by necessity must be self-aware and understand its own body plan, it must understand its environment and continue to evolve its ability to anticipate, understand and distinguish meaningful behavioral information in real-time. The vehicle amongst vehicles is only part of the road network and cyclists and pedestrians at times occupy this infrastructure as well. This identification of behavioral traits allows the vehicle to identify and respond. Still in early development the necessity to understand and develop anticipatory methods to address exceptions and not only rules is where the systems computational framework is moving. Through hundreds of thousands of hours on the street this history gives it a meaningful understanding and yet the need to safe guard demands the system evolve further with a heightened awareness of the latent and unknown. Latency and uncertainty by necessity constructs the need to pursue adaptive systems as in the manner that John Henry Holland has discussed and written in his seminal publication on the subject *Adaptation in Natural and Artificial Systems*.[13] Through the use of artificial intelligence and evolutionary computing Holland's model of adaptation would evolve through communication of signals and boundaries. As a generalized block principle this allows the systems within this framework to operate in processes that are scalable and high population.

13 See Appendix for a transcribed conversation with John Henry Holland prior to his passing we discussed his seminal writings in *Adaptation in Natural and Artificial Systems*.

The thesis has demonstrated through real-time interventions the capacity for design frameworks to enable participation and active observation. Through prototyping the research has constructed proof of concepts, as live experiments have been tested and have given valuable feedback through users interaction. Iteration within this research also affords a context specificity of our prototypical systems. This context awareness allows our system the capacity to adapt to various environmental and social needs. This has been exhibited in works like Memory Cloud, which was installed in four varied sites and contexts during this research.

Human Human frameworks articulated concepts of enabling and explored how by fostering participation and willful contributions novel forms of communication could animate the built environment through conversation. Interventions within the public domain allowed for active participation and observation to challenge the habitual and allow for an open and shared exchange of the collective. *Human Human* interventions are armatures for human communication and expression. Through these interventions a platform for the voice of participants manifested. In the second chapter *Human Machine*, real-time behavioral robotics showcased the capacity for emotive, aural and gestural communication. Machines through their behaviors could exhibit life-like features that would gain empathy from participants or express emotions such as love or anger. This human machine interaction opened up the possibility to see conversational partnerships forged through interaction. The research considered an alternative to production-based robotics towards behavioral creatures that are emotive, that give companionship or challenge people. The final chapter *Machine Machine* moves beyond the human centric relationships and explores how machines could interact with other machines. Units of interactions examine high population collective orders that have the capacity to be mobile, self aware, to self-structure and self-assemble.

Cedric Price once said, “Technology is the answer.” He quickly followed up his statement by asking, “What was the question.” As we consider design today it is ever so important to develop strategies in which architecture can be shared and collective. In creating a context for this to happen it is through participation that we are enabled. When we consider adaptation it is important to recognize that in most instances it is the human component that remains the most adaptive of the systems being explored. Through an empowerment of the public architecture can give space agency and allow us the ability to construct a more optimistic future. If participation gives us the affordance of interaction, behavior gives us the means to evolve new models for design. Through the design research under taken within this thesis three frameworks have given legibility to alternative tracks that one could explore our evolving relationship with technology today. As we examine what architecture could be instead of should be could we allow for a new world of design practice and thinking to emerge. Sometimes buildings is not the answer and that is ok… If Holien stated in 1968, “All is Architecture” I would argue today “All is Behavior.”

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APPENDIX

JOHN HENRY HOLLAND AND THEODORE SPYROPOULOS IN CONVERSATION

Theodore Spyropoulos: One of the critical features of what we have been calling Adaptive Ecologies has attempted to explore generative and behavioral forms of systemic interaction. It came about as a response to pressing and accelerated forms of urbanism that were historically unprecedented. The agenda sought to engage poly-scalar relationships within architecture and urbanism and ask if computation would be able to allow architects to participate and evolve a means to engage with this complexity today. Beyond issues of master planning we set out to engage through computation a means of examining principles that could build relationships within three distinct scales; what we considered was the scale of the master plan(collective), the scale of the block/building (cluster) and the scale of the unit. These scales historically have been treated with a degree of autonomy but within this framework we set out to explore processes that could see them part of evolving system or ecology. Our ambition was to explore and develop systems that would acknowledge uncertainty and latency as critical features examining a time based and scenario driven implementation as we moved towards a computational form of urbanism.

At the heart of these questions were issues of adaptation and systemic methodologies that would enable these systems to address a host of problems. Within the context of computation your work on the subject of genetic algorithms within these ecologies have been of great interest and it would be great if you discuss how your ideas of adaption have evolved since your seminal publication in 1975, *Adaptation in Natural and Artificial Systems*?

John Henry Holland: Well let me start with adaption and make a point of contrast. Even now, in almost all text books on biology, you'll find statements about mutation driving evolution. But, in fact, if you start to look more closely, it is quite a different process. Mutation actually uses sets or clusters of values which are deemed and recombines them so that the easy thing to say is that each of us is a combination of some characteristics of one parent and some characteristics of the other. And this is this process that occurs in every mammal individual in every generation and various things cross overall, recombination, whatever you'd like. But that is the main source of variation. Mutation is a one in a million to ten million, in fact, DNA mostly tries to protect from mutation and recombination occurs in every individual in every generation.

So, this is sort of the lego block approach to adaptation in the sense that you can make a tremendous variety of things with relatively few types of blocks. And I think that turns out to be very important when you talk about interactions of agents because these agents are supposed to be sending signals back and forth and these signals are in fact defined or produced by combinations of pre-established building blocks. So this is you know, this is all the business of grammars and so on and so on where you can have a relatively small vocabulary and get a tremendous variation in your semantics.

TS: Yes this vocabulary that you mention of simple rule-based grammers is very interesting as they are influenced and evolve as a continued dialogue with their environment relative to their populations. These interactions are constructing fitness criteria through this engagement.

JH: And to me at least, well not to be alone, I would put great emphasis on the ability to take a small set of building blocks and then construct at one level up a building block that can be used at that level as much as the lower ones were used at the lower level. I mean with new things, but with it seems to me if one traces the course of evolution for instance you find a progressive building of hierarchy where the building blocks at one level serve in certain combinations, in selective combinations for building blocks one level up. And of course, in another sense, this is really the story of hierarchies in science where you go from nucleons to atoms to chemistry and on and one. The process that this is of hierarchy seems to be critical step along the way and if I look at even a biological cell I see a tremendous range of little bounded entities inside the cell, the organelles, each of which has functions and then those functions become agents within the cell to interact.

So, I put a lot of emphasis on signals and boundaries, the construction of boundaries and the signals that then some of which can go through the boundaries and some of which cannot. This co-evolution of signals and boundaries seems to me to be a very critical way of looking at the way out of which adaptation takes place.

TS: Yes these are features that we have been trying to come to terms with. Through the design of these environments a series of questions became apparent to address. How through agency could we articulate distinctions through interaction? How do we observe and evolve techniques and tools within this generative design environment that could allow our system to operate and co-evolve? Could adaptation in these environments evolve through their ability to learn?

This reminds me of your points on continued and co-evolving relationships as you were mentioning between signals and boundaries, they take on orders of great complexity and magnitude when one considers the implications in the built environment in particular at the extreme scales of urbanism and materiality. This was very interesting to us to explore.

It brought to mind a lot of the early discourse that was coming out of Second Order Cybernetics that was addressing the observer and the relationship of interpretation of what was being observed. As a design problem, coming from the perspective of an architect who is interested in this world of understanding it became critical to identify distinction, variation and pattern. To see intelligence as a product of interaction that challenged the conventions of generative vs parametric discourses that were symptomatic of the bottom up vs. top down methods. Could you discuss the issue of control and the role of simulation in your thinking?

JH: Well let me start with the notion that may be helpful here: let's think of an animal that is in an environment and is trying to learn about that environment. So it is starting, we could even think in a certain sense that is starting with thinking in a certain sense that is close to a tabula rasa. And okay, so the animal starts and it has a rule as an initial chance, we said, if there anything moving out there then flees. Now if it has a relatively small number of properties that it could detect in the environment, then it could in fact try out every possible rule that, these are really simple rules that build large equivalents over the environment. So if the detector was moving objects, I'll do this, if it's not, I'll do something else. So you can try this with detectors, just one detector at a time. Call that a default rule, and then in trying to, if it evades that rule all of the time, then it is never going to approach any moving objects. So, let's say it eats some moving objects, or it wants to mate, or something like that, this rule might be right 60-70% of the time, but it will lead it badly astray in other conditions. So

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then the next level is to have an exception rule, that says: look it's moving, and it's small, and has a winged approach. Now, if this rule is used with more detectors and more information but it doesn't try to form this exception until it has a default rule that works statistically better than chance. So, the moving flea moves better it chance but it has a lot of exceptions. So now it builds exceptions. And it can have exceptions within exceptions and so on. So, we call this a default hierarchy. And it works well in any learning system because you learn the broadest correlations or however you want to call it, both things first, things that are statistically better than random, and then you begin to build the exceptions which use more information and the exceptions to those which use still more information. And when we look at this in terms of learning, building this thing is much faster, and it is nicely scalable that it would be to try to discover all the rules at the level of greatest detail. So this is one thing that we paid a lot of attention to when we talk about learning and scalability, this notion of starting with very broad equivalent classes and then using refinements of that equivalent class and so on. And again, this is a kind of building block approach based on whatever the gauges or detectors or pattern recognizing devices you have and it seems to me that this may fit rather well with your notions, of starting the bottom up thing deals with components of individual buildings and the top down, the whole urban environments are even a larger thing, and this might fit well with that.

TS: It very much does. I mean, one of the things we are responding against was the conventional form of architectural thinking with respect to a "master plan", this was due to the fact that it makes the assumption of a fixed and finite condition, but on the contrary it has to be to flexible and open to evolve with the constraints of an ever changing condition. Change over time is a certainty, the design of systems that take this into account would allow the city to evolve and develop and implement the system while maintaining or mutating principal features of continuity.

In practice when we look to computation there have been two schools of thought. They have each emerged from a fundamental difference of control (Parametric and Generative). They reinforce the top down / bottom up discussion in the most primitive form. With my students we have been speculating in the domain of the generative that moves towards your work experimentation with second order cybernetics and systems theory because for me, many of the features remain unknown. And the best sort of way to cope with that is to allow for multiple agencies to develop this. And in many way it features aspects which are more human and behavioral in terms of defining environments, engaging feedback that can build up data sets which can start to influence these environments, on the other hand, it's really trying to speculate on the fact that the master plan isn't a blueprint and possibly we could look at models that are more synergic in reference to models like the termite mound and so forth as ways of signaling and rethinking the construction and the making aspect through basically implicating also new ideas of fabrication and 3d printing and so forth.

JH: That sounds very good to me, but of course I am biased. There is something that you may find, it may sound not quite so relevant, but you may find it very interesting. There is a, it is more of a software, it is large simulation I guess you could call it, RAHS in business used by Singapore. Risk Assessment and Horizon Search which is relevant to what I think you are interested in. This is open software, they use this, the students in the university use it and so on, but it is in fact under the dice of their permanent secretary. And the idea is to come up with things that may be shocks to the Singapore economy, such as fall offs in petroleum rating, or that fuel will cause a reduction in tourism in Singapore. Anyhow, they try to come across various kinds of things that are possible that could affect the Singapore economy. As you know, it is a small island nation with

no sort of defense against these things. What they do is then instead of trying to predict, what they do is they look at the shock and say what are the ways that we may try to ameliorate the shock? So they are not trying to predict in detail the affect of a shock, or predict what shocks are going to occur, they are trying to prepare ahead of time, you might says knobs, that they may at least come out to be better prepared than if they don't do anything or do things at random. And I find this to be very interesting. It is the only case that I know of, there may be others, where a kind of simulation of a nation is aimed in that direction.

Singapore, again as you may know, partially because they are a high level dictatorship, they can do things that may be more difficult elsewhere. So, for instance, 60% of the people in Singapore hold houses, essentially condominiums, which Singapore requires that each of these relatively large units, the proportion of each ethnic group be roughly the same as within the city as a whole. This is remarkable! It means that all of the local markets have a wide variety of the ethnic foods and ethnic entertainment and so on, the housing, there are no ghettos in Singapore where you have largely only Chinese or largely only Malay or something like that. It has a real affect on that city that I find just, really, rather astounding when you look at other parts of the world.

TS: Yes, I think this is definitely something for us to look into. Going back to this idea of learning, because I do think it is very critical feature not only in terms of actual methods we are using but the way we examine design research. One feature of our student's work is that it is team-based and collective… it doesn't sound radical in the scientific discourse but in the architectural discourse students are taught generally as individuals.

JH: That is certainly largely true here as well.

TS: The role of a participatory and collective frameworks for design is an interest of mine and an important catalyst in understanding how agency offers an approach with respect to learning environments. I was looking at people like Gordon Pask and other second order cyberticians, particularly the British camp. Pask in particular was influential at the AA where I teach as well with Nicholas Negroponte and his Architectural Machine Group at MIT.

The ideas that I find very important in considering systemic practice is allowing them to interact and exhibit features or desires. For example, one of the things that Pask was mentioning was that man is very much interested in novelty. As long as an environment constructs novelty and there is an active conversationally-based dialogue, adaptive features would exist. One of the most straightforward examples was basically, he was trying to design systems that could get bored. That if through particular patterns, if there was a certain repetition, it would start to introduce and intervene with the exchange. I was wondering in terms of the thoughts that you have with respect to simulations or even like projects that you are working on, such as Echo models, how do you see this kind of aspect of the environment? Because you mention a lot kind of real world examples where you could apply a lot of the features you are discussing on economies, on ecologies and different sorts of features that move between, let's say, social forms of interaction and maybe more sort of ideas of actually observing like in the biological sense, or constructing models that build representations of processes that are out there. I am curious with respect to learning, that if you feel within the systems if they could also become part of the adaptive features?

JH: Yes, you started me thinking. Let's go to this notion, it's a little Echo-

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like. Let's assume that we are building simulated agent, which has some reservoirs that it must keep from going empty. So it has a reservoir for water which is driven by thirst, and shelter which is driven by fatigue, and so on. It's possible now, so we have one of these default hierarchy of rules, which for each environment individual situation has something to do and these rules are rewarded if eventually they chain into something which fills one of the reservoirs.

Now I won't go into that but there are various reasons to do this in a reasonable, localized way, so you don't have to go into referees spanning outside the system telling you whether you did well or not. Anyhow, so we've got the reservoirs and it is possible to make a reservoir for novelty. And that reservoir is only received in increments if in fact the agent encounters the situation that is not well-handled by any of its rules. This is something that is actually testable and easy to set up. And it means that as long as the other reservoirs are kept at a reasonable level, then and only then, can it get increments to this novelty reservoir by moving in directions which do not actively waste the well-established fuels. Now, that turns out in these agent-based models to yield some very interesting activity whereas the agent early on certainly does try to keep the basic reservoirs reasonably full, but then when it gets rid of that in its environment, then it starts seeking out novelty. But when we did this, well we didn't do it exactly this way, but when we built the artificial stock market, this turned out to be important.

So, for me, the idea goes along the lines that you were saying that is important that not only the organism be comfortable and feel that in case of a need it knows what to do, but also that it has compliments that make it explore its world.

TS: Yes, I agree that this is very interesting area. I would be curious if you would you consider then an agent as a designer? In the sense that thinking of people like Victor Papeneck, the discourses of Heinz von Forester and a lot of the radical Constructivists who took a sort of attitude that all features of cognition and so forth were a constructed acts. And I remember reading recently Tree of Knowledge and they basically were articulating a statement where the knowledge of knowledge compels. Papeneck was always stating the fact that he thought that all humans were designers, and it is a sort of most primal form of human activity. That he would I think consider that obviously he is talking very much as a designer in the world of human behavior and social change, but I think that extends into maybe some of the more biological systemic aspects about reproduction and other features that agents exhibit.

As an architect the role of design, and what constitutes design within an agent based system is an open question. I may be wrong for thinking this, but if a system exhibits tendencies towards novelty and varied decision-making as it is building up its hierarchies and complexities an opportunity emerges as form of knowledge and understanding of itself within an environment. This embodied knowledge could allow a system to evolve or co-evolve. Do you see design as part of your discourse?

JH: Yes, it depends of course there are many, or at least several, interpretations of the word and the concept of design. But at least from the wayI tend to look at these things, once we allow for this kind of hierarchy of conditional interactions, then really when we look at it this way, we have co-evolution going on both within the agent and also between agents. And you know, various rules in the devolved hierarchy are co-evolving and if we look at the parts of a biological cell, the organelle, certainly over evolutionary periods have co-evolved. So in one sense I am very much a constructivist in the sense that I do believe in that these

things are generated from well-defined basic building blocks, if you have to define the level in which you pick the things to be basic, in which we are talking nucleotides or amino acids, or whether we are talking a range of organelles in a standard cell as basic, that's a choice at the level of design, but from that point onward, I don't see these things in the sense that we've been talking about as emergent from the construction, almost in the same way as if I gave you a set of adjectives, then there is of course a set of synonyms implied, which doesn't mean I know what they are, but with in time, I will have this set of, call them basic theorems, which play an important role because this creates a bit of a mud there as there is a tremendous amount of theorems which are not important and not basic. But, the process of selection is useful in such that I come across the pathagorem theorem, that is the basis of a lot of properties of other theorems so there is in this process there are those things that emerge that from the point of view of network theory would be helpful.

TS: Networks and frameworks are really part of the process, on the one hand, we are dealing with issues of organization and how we distribute, it can be programmatic features, they can be a series of different ways of subdividing or partitioning space, but on the other hand, we're trying to speculate about different ways of thinking about materiality. This is where it becomes very interesting because it seems that then we target generative design systems and generative systems, I call them design systems only by the purpose that I am using them, they seem to make more explicit criteria the parameters, like the rules of engagement if we take it in the construct of a game or so forth, when you are dealing with respect to material properties, and those behaviours rather than social behaviours and so forth, so we are always trying to at least trying to tease out alternative models other than what is existing, within, let's say different kind of typologies of space and so far, this is one of the features that

I find quite fascinating that looking at these ways or frameworks allows us to really have a diverse understanding of what is going on around us. At the same time though one of the features I thought was really interesting was that in your development in more the echo model, you really tried to strip away any really situation specific ideas. For us, for example, we have been trying to develop an idea of architecture being a very prototypical and scenario based system so that we don't get overly committed to very particular features of a site or particular system and allow us to actually build models which have a variety of applications. This in architecture is not very common, actually, it is seemed at times almost blasphemous, to have something not specific to a site. And I am imagining in a lot of the sort of discussions you must have had since the publications, particular in the first book, I am sure that conversation must have changed a lot as these things have sort of evolved. I'm just wondering how if, if you could just very generally, I read the preface recently of an edition of Adaptation and Natural Artificial Systems and you had mentioned that when the book was first put out that it didn't seem to generate that kind of involvement, but through time obviously these things have become much more applicable. The same has happened in architecture, many of the people who were very forward thinking like Negroponte or John Frazer and these people, they were really dealing with computation but without really direct access to this kind of much longer network society that we are living in now. So it moved directly into communication and had lost the physical properties of the architectural discourse that maybe put it on the table. I'm just curious if you have seen the trends of thinking through these systems evolve and become much more applicable to how we're living today in these environments?

JH: It has been an interesting thing as you say for almost two decades which is largely only in my students and their students who are interested in this.

But it is that we begin to get more of these problems that could not be solved in the classical way of optimization. And that began to turn people's attention to things like genetic algorithms, they were more aimed at improvement rather than optimization. People began to use these for real problems. I remember one of the earlier ones was Canadian Air used this for scheduling pilots because pilots had various priorities and various seniorities and they were surprised that they got much better scheduled than the ones they obtained by more usual methods or by by guess. So that began to spread, and it is interesting, now you find sort of, almost two distinct groups. These large data bases that we are getting in genomes and other areas, there are some methods which are an adaptation, but not a big one, of standard methods where you try to use correlations and things like that to pick out the patterns. And a large part of network theory has taken on these problems, with increased success. But it does not tackle the question of how these questions change and adapt over time, because they are continually changing. And so what is beginning, but just beginning, is the penetration of some of these methods which we have been talking about, including genetic algorithms, into this question of how do networks evolve and how do parts of them co-evolve. But I would say that this is less of one paper in one hundred in network theory even ask that question.

And so it seems to me that what you are doing is very much and very central to changing the landscaping, changing the way of looking at architecture, this seems to me to be a very important thing in the sense that it is, in the same sense that if I can do a lot with network theory, but there are limits, and if I try to go beyond that and look at how networks evolve, I am going to lose a major console of understanding there.

TS: One of the byproducts of posing similar kinds of questions relative to architecture, was looking towards models that implicated alternative models of ecological and material engagement. The stigmergic model was a very interesting one, issues that deal with materiality and looking at strategies of deposition and other features that we find actually in maybe more primitive forms of architecture have somehow through this kind of industrial processes that we've gone through over the last one hundred years or so have somehow fallen out of the idea of making. And I think computation at the moment, and let's say our limit of working within that, it started to unfold a very interesting series of objects for us that could really look at onsite materiality as a viable way of thinking about a certain kind of architecture. Even if we didn't start out with the idea of site specific and we were talking about scenarios and systems that could become hyper specific, what became very existing, like actually through that and moving beyond the abstraction and thinking, well what does that mean when we start thinking about materiality and so forth, these very on site feature started to become solutions or possible ways of addressing some of these concerns in a very new way. So I am believer in these things, but I have to be honest, it is very new in the field of discourse that we have been talking about so a lot of the things that I have been looking at are Walter Grey Walter's tortoises or things like the homeostat and your research and a series of other people who have been constructing these frameworks that conceptually speaking for designers I think they are very important. And working with the students anyway I think we have started to tease out some possibilities. By no means is this a new solution space but I think that it is posing alternatives and we've tried at least to consider that with respect to this issue of time, which you mentioned which I think is a very critical feature for architecture and because one of the sites for example what we used as a scenario was the Shanghai Expo site…

JH: Oh yes!

TS: The theme was better city, better living and there was an attitude towards the city that had an accelerated , that did not work in their favor that no matter how many people were invovled or how many resources, architecture makes very particular demands, and it's clear that these things just become stage sets and somehow what we have been trying to speculate is that at the heart of it, as functions and changes and obviously the city becomes a very active model that does exhibit a lot of the features that we have been talking about, it also can be tapped into and we can build in concepts of boundaries and concepts of how we can think about having a more generative way of looking at how we even start to construct, because they wanted to basically master plan 5.5 square kilometres worth of space and they did it in a very traditional way, which means the plan and the implementation actually over the period of that short duration wasn't exactly the same. These are just things that I am not sure what you think but these are the some of the things we are trying to target with the research that we have been developing.

JH: So you make me think of a couple of things. The 1930's Chicago World's Fair has still influences on that far south side of Chicago, you know, the Museum of Science and Ministry and that mall and even the campus of the University of Chicago and I was thinking just recently when I was in Beijing the huge park with the, I don't know the hill, several hundreds metres, they made a hill and it is called the Olympic Forest, they made a hill there from the excavations for the Bird's Nest and so again on a relatively short time scale they created one of the most popular parks in Beijing, in the city. And this kind of unexpected in some way, looking at possibilities seems to me terribly important.

TS: I think this is the only way, honestly, that I can see at least however we can sort of participate as architects in the conversation to be very quick and able to develop systems that will show not only variations like they would just select one but try to think beyond the building itself and to see how these possibilities could evolve. And these are features that I think very much at the heart of today, which is supposedly something that is very different. Yet at the same time it seems that architecture, for many people, is the one point of stability of something non and it has basically responded to a kind of trend of not really allowing people to affect architecture. Most architecture is not really built by architects or designed by architects in any capacity. So that kind of idea of the cities that we are living in and the roles that architects can play within them is very important, the ways that they can engage these kinds of thinking, because it allows us to offer something very possible, and try to find better ways of thinking to better implement these things.

JH: Well, I am so much a fan of cross-disciplinary kinds of things as ways of generating kinds of metaphors which you can then take from one field to another and to only suggest, but often very truthfully suggest new ways to move towards new possibilities. It just seems to me that the long-term trend towards disciplinarity loses.

TS: I've seen it in the kinds of conversations that obviously we've been involved in, and I think very quickly computation has become a framework that allows people to actually see. Because we develop scripts and we do basic programming and we use basic tools to simulate and use different platforms, many of which haven't been designed for architecture but at the moment it is allowing us a kind of discussion that I think has been allowed at this kind of magnitude only very recently. And I think the kinds of conversations become very exciting because it becomes not only a de-mystification, it's actually just a more acute understanding of what it is these disciplines actually do. I am in

complete agreement with you that we need more inter-disciplinary approaches towards design but they seem to only really become fruitful when there is a real need or demand when things become quite extreme and conventional solution spaces are not really giving results. And I think this is the time, today, that this is the case because we've had many conversations with people who are looking actually at simulations that we do and see very different kinds of problems that could be addressed with it. We had a recent, I gave a lecture recently at the University of Pennsylvania, part of the medical department was actually there, something called LAB studio within the architecture department, by telling you about how much information and data sets they actually have, 2D prescriptions and because a lot of our by being spatialised is implicating 3D and 3D environments with time, critically, they saw it as a way to stimulate ideas so that they could also find different forms, lets say even new forms of graphic visualisation for information graphics. And that could be useful for the scientific community and so forth. I think this is a very important time, let's say for us, to sort of speculate loosely about opportunities. But Mr. Holland, I don't want to keep you very long, I mean you have been very generous for your time, and it has been a real pleasure to talk to you about some of these things. Would it be okay if I transcribe this I could send it through to you and if there were any other questions maybe I could send it through via email?

JH: Yes, I would be interested, I would be quite interested. [Interview ends here, minus goodbyes and pleasantries]

PROJECT CREDITS

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Facebreeder, AA, London, England, 2005
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Smoke Signals, Bristol, England, 2007
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Brunel Gateway, London, England, 2007– Current
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Becoming Animal, Suffolk, England, 2007
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Archigram Revisit, 'Imperfect Works', London, England, 2008
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Archigram Revisit , 'Mega-Structures Reloaded', Berlin, Germany, 2008
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Memory Cloud, London, England, 2008
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Petting Zoo, London, England, 2013
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Emotive City, London, England, 2016
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